POWER

Volume 60 New York, August 26, 1924 *No.* 9

The Master Mechanic

I WAS walking through the yard of a down-east factory with the agent when we ran across a man sunning himself on the stone doorstep of one of the mills.

"That fellow," said the agent as he returned his good-day, "does less and draws more money than anyone on the job—but when anything goes wrong he's the whole works."

"Trouble man?" I asked.

"Master mechanic."

How did he get that way? Why was his the master hand and the master mind in times of accident and confusion?

Because he knew what to do and how to do it.

Instinctively? Perhaps, for a lifetime of dealing with such occasions begets in some men a readiness and ability that is akin to instinct.

But there are a lot of men who have been millwrighting all their lives, who have been through scores of difficulties and accidents, who are fit only to take, not to give, orders when an emergency comes.

Not all who go through the School of Experience get their diplomas. They put in years of time, but do not learn their lessons. And when the examination comes, in the shape of a time of stress and an opportunity for somebody to prove his mastery, they fail to qualify.

The agent's master mechanic did not look like a scholarly man. I doubt if he knew what a moment of inertia was; but he knew how big a beam he needed to carry a given load, and where to take a bight that would hold and lift, and how to handle tackle. He knew when an engine or waterwheel or jackshaft was running right and how to set or fix it if it was running wrong.

And although he sat around and sunned himself when the mill was running and all was going well, he doubtless put in many hours of work that the agent did not see when the "speed" was off and the looms and spindles still, correcting minor troubles before they became great, making renewals and adjustments that could be made only when the mill was shut down, forestalling accident and delay by wise forethought and timely attention.

And as I pictured him afterward, sitting there in the apparent idleness that had inspired the agent's remark, I thought that he might not have been so idle after all. He might have been just studying his lesson, thinking that this or that was going to need attention soon, and how he should handle it, or what he would do first if so and so should happen.

F. R. Low

It is this kind of thinking that makes the ready man.

MODERN plant designed to supply electrical energy, compressed air and heating steam for the operation of an activated sewage disposal plant. Steam supply for heating sludge and recovery of heat from purified sewage made an interesting problem in design.

Power Plant of Milwaukee Sewage Disposal Works

AFTER years of study and practical demonstration in a testing plant, the City of Milwaukee has developed one of the most modern and efficient sewage-disposal systems in the country. It is to be operated on the activated sewage principle with numerous innovations to facilitate the process, including the recovery of sludge for the making of fertilizer. The project is now nearing completion and when ready for operation will serve in the city and the metropolitan district surrounding it, an area of 151 square miles with a population approximating 575,000.

Fig. 1—General view of turbine room of sewage disposal power plant

The activated sludge process of purifying sewage involves in general the following order of procedure: the coarse screening of the raw sewage to remove large solids, the settling out of the finer and of the raw sewage to further remove suspended matter, the aërating of the sewage by means of compressed air as it flows through large basins, the first separation of the sewage in the aërating basin from the sludge proper, which is further treated in the clarification basins before being suitable for discharging as purified, and the return of the sludge to the pumps to be delivered to the filters. These processes, together with the drying and preparation of commercial fertilizer from the solids filtered out of the sludge, put before the designer the problem of a power plant containing air-compressor equipment, turbo-alternators for driving pumps, filter drums, screens, conveyors, together with the operation of drying equipment and the co-ordinating of a seasonal heating demand, resulting from the necessity of heating sludge before filtering in cold weather, with the attending power requirement. The heating demand, 2,000,000 gal. daily from a temperature of 50 to 160 deg. F., proved to be so large that it was not only taken care of by exhaust steam, but heat exchanger equipment was provided for recovering the heat in the sludge effluent after the filtering process was completed. The quantitative flow diagram, Fig. 2, made from a hand sketch prepared by W. J. Sando, consulting engineer, will give an idea of the system as a whole. The following outline of the process will help to visualize the demands made upon the power plant serving the works:

Sewage and industrial wastes are brought to the plant on Jones Island through a system of intercepting sewers terminating in four inverted siphons, two low-level, and two high-level, under the harbor entrance 75 ft. below the water level. The two low-level conduits join 16 ft. below lake level and discharge through four coarse-bar cage

screens to the suction of three vertical, single-stage, variable-speed wound-rotor automatically controlled motor-driven centrifugal pumps which discharge the sewage into a concrete conduit where it mixes with the high-level sewage.

By gravity the combined high- and low-level sewage is passed to a grit chamber 95 ft. long, 8 ft. wide, and by hydraulically operated sluice gates the compartments are controlled so that an average rate of flow of from 0.74 to 1 ft. per second can be maintained. At this velocity it was found that the heavy mineral settleable solids would drop out in 95 ft. length of flow and carry with them the minimum amount of organic matter. From the grit chamber the sewage passes through fine drum screens, which remove on an average 78 lb. and a maximum of 536 lb. of suspended matter per million gallons of sewage treated.

The screens discharge into a concrete conduit in the bottom of which are filtros plates through which compressed air at about 6 lb. pressure is forced to mix the sewage mechanically with activated sludge. The mixed sewage and sludge pass on to the aërating tanks with filtros plates in the bottom through which air under 10 lb. pressure at the compressor passes. It requires about six hours for the sewage to pass through the tanks. The flow continues over weirs and through venturi meters into mixed liquor conduits which are channels surrounding the three sides of the sedimentation tanks.

From the conduits the sewage passes into the sedimentation tanks through submerged and adjustable orifices where the suspended matter settles in the form of sludge, leaving the liquor to flow over the top of troughs into the effluent conduit to be discharged into the lake.

In six or seven hours the raw sewage has undergone such purification that the liquor emptying into the lake is as clear and colorless as drinking water and will show an average reduction of 98 per cent bacteria and 97 per cent suspended matter.

By means of the hydrostatic head in the tanks the sludge is forced out continuously into conduits leading to the return sludge well. For its removal three 20-in. centrifugal pumps have been provided. The sludge is forced through a 48-in. main into the conduit from the fine screens where 90 per cent mixes with the incoming raw sewage, and the rest passes to a submerged reservoir outside the filter house. In the reservoir the sludge is mixed with sulphuric acid, which increases the efficiency of the filters in removing the water from the sludge.

A 2,000,000-gal. centrifugal pump removes the mixed sludge from the well and forces it through a series of heat exchangers in which the temperature is raised from 50 deg. F. to 120 deg. F., this heat being obtained from the hot filter effluent. The sludge is then passed through a preheater where the temperature is further raised to 160 deg. F. or to any desired temperature up to 212 deg. F., the necessary heat being supplied by exhaust steam from a heat-balance turbo-generator and from two vacuum pumps serving the filters. The filters remove the sludge from the water, producing a thin cake containing about 80 per cent of water from a mixture that contained 98 to 99 per cent of water. The water thus removed passes back through the heat exchangers to help raise the temperature of the cold incoming sludge.

The equipment just mentioned is located in the filter house, which contains 24 filters of the revolving drum type, operated by constant-speed, inclosed, moisture-proof motors. Other apparatus includes receivers, condensers, pumps, air compressors for the screening ejectors, vacuum pumps for operating the filters and the heat-balance turbo-generator supplying just sufficient exhaust steam to meet the heat requirements of this system. This unit is rated at 1,250 kw. and is arranged to operate either condensing or non-condensing. During the summer if there is no need for applying heat to the sludge for filtering purposes, the preheater will be used as a condenser for the turbine and vacuum pumps and the economy of these machines improved.

It was only by utilizing exhaust steam in this way that the cost of heating the sludge could be confined within practical limits. The cost of live steam would have been prohibitive. It has been estimated that the cost of fuel for heating the sludge from 50 to 160 deg. F. will be $1.60 per million gallons of sewage treated and $1.52 per ton of dried sludge produced, assuming $6 per ton as the cost of coal and that sludge must be heated 212 days in the year.

From the filters the sludge is conveyed while hot to rotary indirect driers, in which it is subjected to a temperature of approximately 700 deg. F. and dried to a 10 per cent moisture basis. From the driers the material passes through rotary screens, the fine material going to the mills, by which it is ground to a powder, and the coarse stuff passing from the screens into the undried incoming sludge and for the second time through the driers. The material is now in the form of an ammonia tankage ready for market as made or for mixing with potash and phosphate into a complete fertilizer. It is estimated that 1¼ tons of dry tankage will be obtained from every million gallons of sewage, so that an initial production of 100 tons daily is expected.

Each of the drier furnaces is equipped with a traveling-grate stoker which is motor driven, as are also the forced- and induced-draft fans and all the auxiliaries in the filter and drier houses.

From the foregoing it is evident that a great deal of power will be required for pumping, screens, revolving driers, fans, filters, conveyors and the coal-handling machinery. It is anticipated that the ultimate connected load will approximate 3,800 kw., much of this being three-phase 440-volt 60-cycle service with induction motors. To correct the power factor, two 125-kw. synchronous motors driving 500-cu.ft. air compressors are installed in the filter house. The connected lighting load for buildings and grounds totals 350 kw. When treating 85,000,000 gal. of sewage per day, it is estimated that the air requirements will be from 85,000,000 to 127,500,000 cu.ft. per min. at approximately 10 lb. pressure. Other services, such as the vacuum for the filters, the heat for the driers and the exhaust for heating the sludge, are cared for outside of the power plant proper, except that the steam is furnished by a common boiler plant.

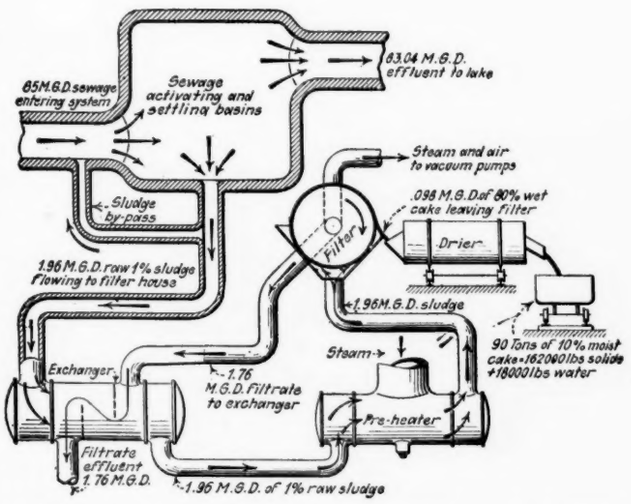

65 M.G.D. sewage entering system
Sewage activating and settling basins
83.04 M.G.D. effluent to lake
Steam and air to vacuum pumps
.098 M.G.D. of 80% wet cake leaving filter
Sludge by-pass
Filter
Drier
1.96 M.G.D. raw 1% sludge flowing to filter house
1.96 M.G.D. sludge
90 Tons of 10% moist cake = 162000 lbs solids + 18000 lbs water
Steam
Exchanger
1.76 M.G.D. Filtrate to exchanger
Pre-heater
Filtrate effluent 1.76 M.G.D.
1.96 M.G.D. of 1% raw sludge

Fig. 2—Quantitative flow diagram of sewage works

To meet the demands just enumerated, a modern power plant, unusually complete in all its details, was designed. The plant has no main operating floor except a subway grating platform around the prime movers in the turbine room and just sufficient floor in the boiler room for convenience of operation; in other words, what is usually the basement floor is the main floor in the present plant. On this floor are the auxiliaries of the main turbo-blowers and turbo-generators which are mounted on concrete foundations 13 ft. high. On the operating floor surrounding these units are the switchboards and the chief engineer's office. A walkway supported on columns gives access at the same level to the

operating floor in the boiler room. From this structure all pipes leading from one department of the plant to the other are suspended, so that all pipes and valves in the plant are visible and there is no extreme heat at any one point. Through a large areaway the boiler-room operator can see the boiler-feed pumps, water-softening system and the forced-draft fans from the operating floor, and on this same floor back of the boilers are the economizers and induced-draft fans.

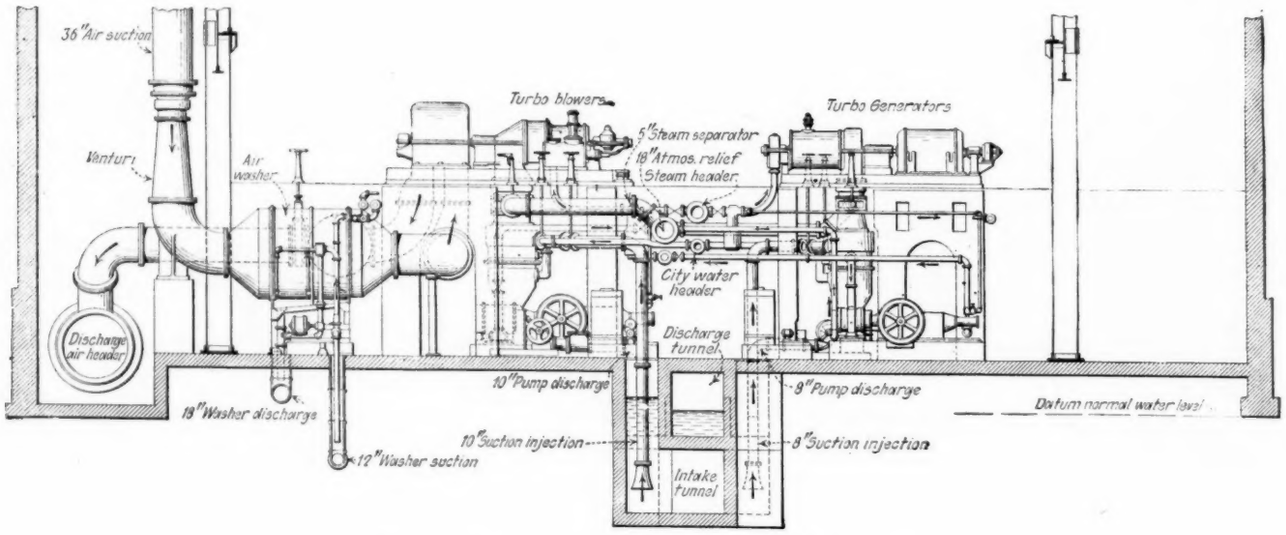


Fig. 3—Transverse section through turbine room

In selecting the blowers that were to supply the compressed air for agitating the sewage through approximately 75,000 filtros plates, consideration was given to four different types of equipment as follows: Reciprocating compressors operated by reciprocating steam engines, hydro-turbine compressors operated by vertical steam engines, turbo-blowers operated by steam turbines and hydro-turbine compressors operated by Diesel oil engines. Prices varied over a wide range, but when economy, coupled with initial cost worked out on a capitalized basis, was considered, the turbo-blower had the advantage and this type of equipment was installed. When treating an average of 85,000,000 gal. of sewage a day, it was estimated that the maximum air requirements would be 127,500,000 cu.ft. To give sufficient flexibility, four units were installed, three of them in full operation being required to meet this demand. Another feature, in addition to the low cost, in determining the selection, was the absence of oil. This was important, as any oil in the discharge of the blowers would tend to clog the filtros plates and cause heavy expense in repairs.

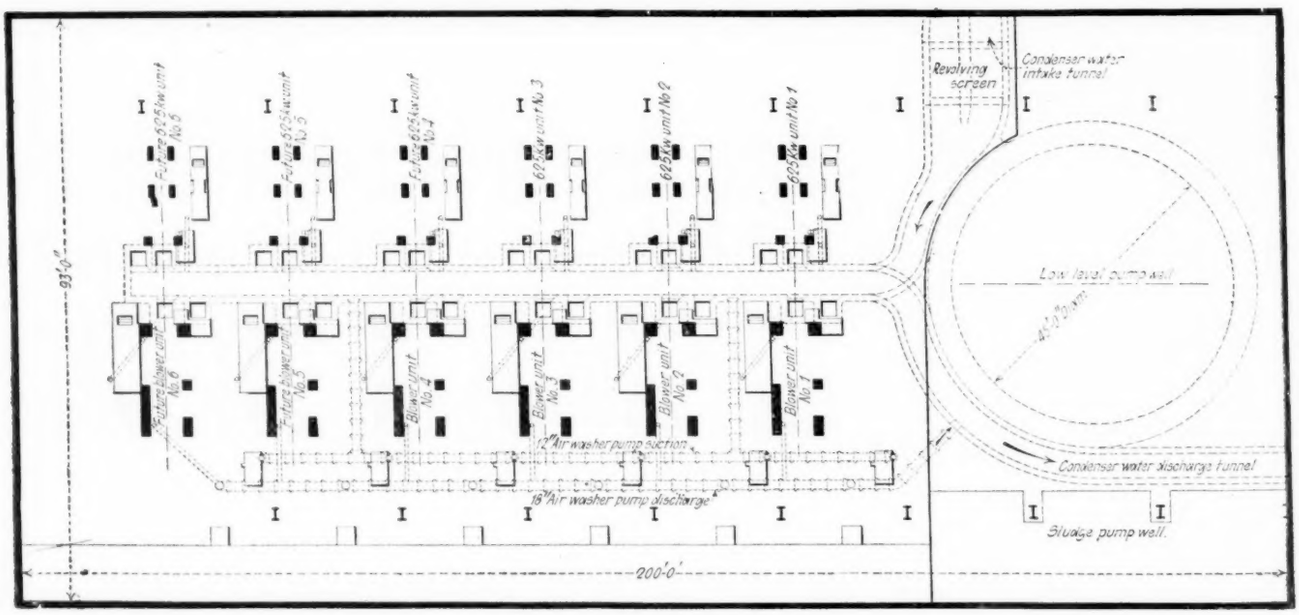


Fig. 4—Plan of turbine room

As about 90 per cent of the air supplied by the blowers is for mechanical agitation, it is necessary that it be delivered without free moisture or dirt to prevent

clogging the filtros plates. To insure clean air, the inlet to each blower has an air washer requiring not more than 10 gal. of water per 1,000 cu.ft. of air. The air inlet is a sealed compartment at the roof level into which air enters through louvers in the outer wall. It then passes down in a 36-in. intake pipe through a

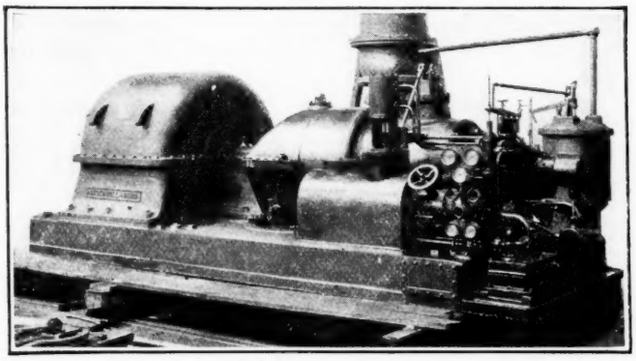


Fig. 5—Turbo-blower on testing floor

venturi meter, by which the volume is measured, to the air washer and on the suction of the blower.

On the other side of the room are the turbo-generators. Three machines are now in place with space for three more, each being rated at 625 kw. at 80 per cent power factor. For the seven turbines uniform condensing equipment has been installed. An abundance of lake water and low first cost were the factors

TABLE I—OVER-ALL ECONOMY OF TURBO-BLOWER INCLUDING AUXILIARIES

Total Auxiliary Horsepower

Condenser Removal Pump:	
(1) Brake horsepower-hour input to jet condenser removal pump	28.7
(2) Motor efficiency, per cent	89.6
(3) Input to removal pump motor, hp	32.0
Air-Washer Pump:	
(4) Brake-horsepower input to washer pump for 297 gal. per min. against 77 ft. head	9.5
(5) Motor efficiency, per cent	88.5
(6) Input to removal pump motor, hp	10.7
Oil Filter Pump:	
(7) Motor-driven triplex oil-filter pump charged with full rated horsepower of motor	0.5
Rotative Dry Vacuum Pump:	
(8) Indicated horsepower of steam cylinder, 200 lb. gage pressure, 100 deg. superheat non-condensing with 28 in. vacuum on air cylinder	11.0
(9) Total horsepower required for all blower auxiliaries	54.2
(10) Manufacturer's guarantee, hp	65.0
Steam Consumption of Turbo Blower Including Auxiliaries	
(11) Steam consumption of turbine, lb. per b.hp.-hr. at 1,650 and 1,700 hp.	10.98
(12) Total horsepower required by motor-driven auxiliaries	43.2
(13) Total equivalent steam an hour required for motor-driven auxiliaries, lb.	475
(14) Total steam used by turbo-blower to deliver 30,000 cu.ft. a minute against 10 lb. gage pressure, lb.	17,560
(15) Total steam used by rotative dry vacuum, lb.	158
(16) Total steam used by 30,000-cu.ft. turbo-blower including auxiliaries, lb.	18,193
(17) Manufacturer's guarantee, lb.	19,200
(18) Guarantee exceeded, per cent	5.78
(19) Steam used including auxiliaries to deliver 100 cu.ft. of free air against 10 lb. gage pressure, lb.	1.011
(20) Manufacturer's guarantee, lb.	1.07
(21) Guarantee exceeded, per cent	5.5

determining the selection of jet condensers. For the auxiliaries a carefully worked out heat balance determined the choice between motor and steam drive. The water-removal pump in each case is motor-driven, as is the oil-filter pump, and in the case of the blower units the washer pump. The steam-driven auxiliaries are the rotating dry vacuum pumps. Intake and discharge tunnels for the condenser water are provided as indicated in Fig. 4. The inlet tunnel is below the river level, so that the water flows into the plant by gravity.

With jet condensers, testing of the prime movers in the plant would not have been convenient, so all official acceptance tests were made on the testing floors of the manufacturers. The results presented in the accompanying tables are indicative of the economy that may be anticipated. For the turbo-blowers the auxiliary horsepower and the over-all economy of blower and auxiliaries are given in Table I. An interesting figure is the steam consumption of the turbine, given as

TABLE II—OVER-ALL ECONOMY OF TURBO-ALTERNATOR INCLUDING AUXILIARIES

Steam Consumption of Turbine

Load per Cent	Lb. per Kw.-Hr. Test	Lb. per Kw.-Hr. Guarantees
50	19.06	20.05
75	17.78	18.3
100	16.92	17.2

Total Auxiliary Horsepower

Condenser Removal Pump:	
(1) Brake horsepower-hour input to jet condenser removal pump	15.5
(2) Motor efficiency, per cent	88
(3) Input to removal pump motor, hp	17.6
Oil-Filter Pump:	
(4) Motor-driven triplex oil filter pump charged with full rated horsepower of motor	0.5
Rotative Dry Vacuum Pump:	
(5) Indicated horsepower of steam cylinder, 200 lb. gage pressure, 100 deg. superheat, non-condensing with 28 in. vacuum on air cylinder	6.67
(6) Total horsepower required for alternator auxiliaries	24.77
(7) Manufacturer's guarantee, hp	29.00
Steam Consumption of Turbo-Alternator Including Auxiliaries:	
(8) Steam consumption, lb. per kw.-hr.	16.92
(9) Total horsepower required by motor-driven auxiliaries	18.1
(10) Total equivalent steam an hour required by motor-driven auxiliaries	306
(11) Total steam used by turbo-alternator only, lb. per hr.	10,670
(12) Total steam used by rotative dry vacuum pump, lb. per hr.	131
(13) Total steam used including auxiliaries, lb. per hr.	11,107
(14) Manufacturer's guarantee, lb. per hr.	11,200
(15) Guarantee exceeded, per cent	0.83
(16) Load on alternator corresponding to total steam used, kw.	631
(17) Steam used per kw.-hr. including auxiliaries, lb.	17.6
(18) Manufacturer's guarantee, lb. per kw.-hr.	17.9
(19) Guarantee exceeded, per cent	1.68

10.98 lb. per b.hp.-hr. The equivalent steam required by the auxiliaries is 3.6 per cent of the turbine supply, and the amount of steam used, including auxiliaries, to deliver 100 cu.ft. of free air against 10 lb. gage pressure, is 1.011 lb., this figure being 5½ per cent under the guarantee of 1.07 lb.

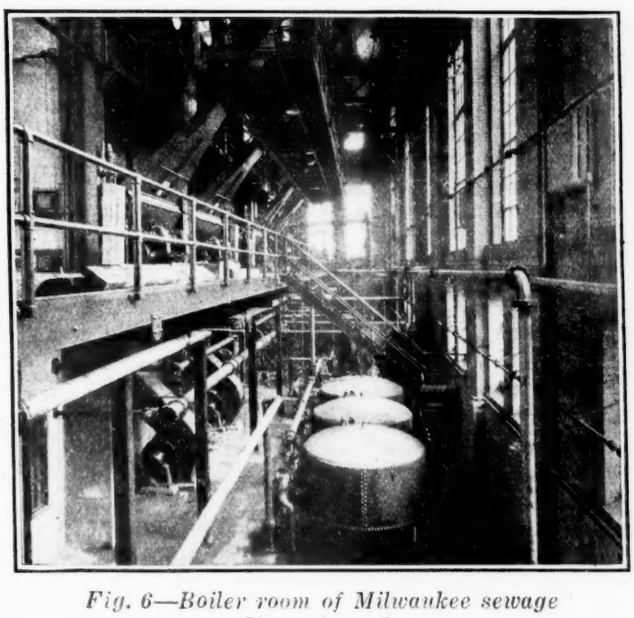


Fig. 6—Boiler room of Milwaukee sewage disposal works

In Table II are the test figures on the turbo-generators, which show a steam consumption for the turbine of 16.92 lb. per kw.-hr. at full load and 17.6 lb. with the auxiliaries included. The steam conditions during the test were 200 lb. gage pressure, 100 deg. superheat and a vacuum of 28 inches.

Other equipment in the power house includes the three main low-lift pumps, each of which is a single-

stage vertical-shaft pump driven by a 250-hp. variable-speed motor capable of operating at one-half, three-quarters and full speed, the speeds being automatically controlled by a float connected with the pump well and contact switches. The individual pump capacity is 30,000,000 gal. per day against a head of 35 feet.

Adjacent to the main pump well, but separated from it, is a second well containing the three return sludge pumps, which are single-stage, double-suction, vertical-shaft type, motor driven and operating at 385 r.p.m.

To lubricate all this machinery, two complete automatic oiling systems have been provided. Each of the seven turbines has its individual filter and pump which draw on a central overhead tank to renew the oil supply as necessary. Another overhead tank and a single filtering unit supplies the low-lift and sludge return pumps.

In the boiler room are four 7,840-sq.ft. cross-drum water-tube boilers, with space for two more, equipped with underfeed stokers, superheaters, forced- and induced-draft fans and economizers. The operating pressure is 225 lb. gage and the superheat 135 deg. F. A furnace volume of 1,850 cu.ft. reduces to 0.236 cu.ft. per square foot of heating surface. An innovation is a steam-jet system for soot removal from the combustion chamber with the primary idea of minimizing the opening of clean-out doors to reduce the admission of cold air on the tubes.

Each stoker is driven by a 5- to 9-hp. vertical engine on the operating floor, and at the side of the setting are the cylinders for operating the steam ash dumps. At the same point is the valve for turning on the water jet in the ash hopper to spray the ashes. Each stoker has an individual turbine-driven forced-draft fan and windbox, there being no interconnection between units.

Economizers have been provided, one for each battery of two boilers. They are of the cast-iron type set on the operating floor with a bypass at the inlet end to permit direct passage of the gases to the smoke flue. Each economizer has an effective heating surface of 8,500 sq.ft., which is approximately 54 per cent of the heating surface in the two boilers of the battery. The fans serving the economizers are of the multivane type and driven by vertical throttling engines. A single chimney serves the boiler room.

Two separate and distinct conveyor systems of the steam-jet type are installed, one for handling ashes from the stokers and the other for handling soot from the combustion chambers, economizers and chimney.

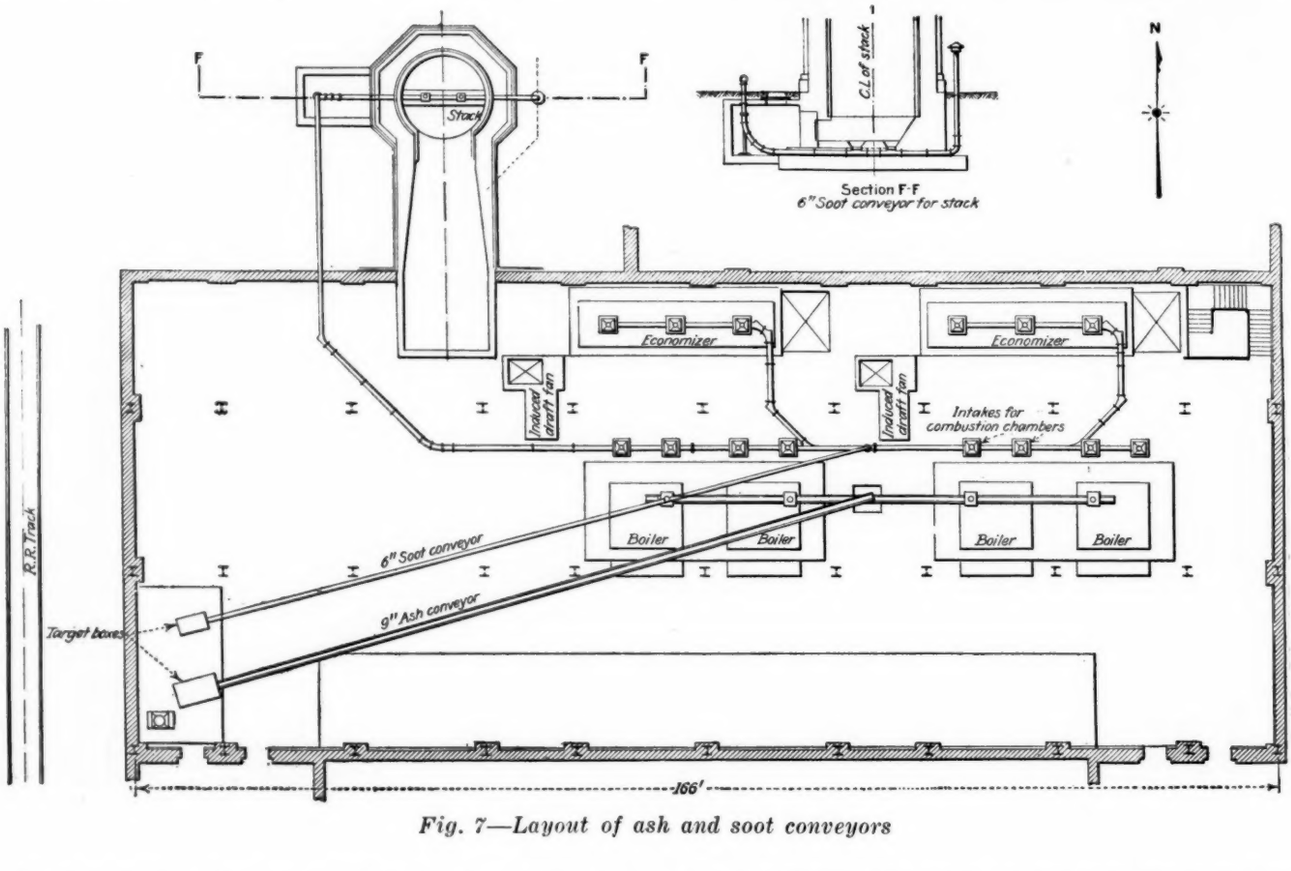


Fig. 7—Layout of ash and soot conveyors

The auxiliary system for the handling of soot and combustion ash consists of a 6-in. conveyor divided into a series of suction lines and a discharge line. Two suction lines having three intakes each serve the economizers, two suction lines with four intakes serve the combustion chambers of the four boilers, and an extension of the suction line under the boilers serves the chimney base. All suction lines terminate at a riser located centrally, from which point the ashes and soot are discharged upward a distance of approximately 73 ft., thence through an upper, horizontal discharge line, a distance of 100 ft. into a second target box on top of the storage tank previously described. The soot and combustion ash removal is to be accomplished by two steam nozzles, one at the base of the riser and the other at a point in the extension to the chimney.

As a steam-jet conveyor involves the use of steam which is discharged into the tank with the ashes, as

PRINCIPAL MECHANICAL EQUIPMENT IN POWER PLANT OF SEWAGE DISPOSAL WORKS

GENERAL

Location of plant	Milwaukee, Wisconsin
Character of service	Compressed air, power and light
Capacity at present, kw	1875
Capacity at present, hp	8,000
Capacity, ultimate, kw	3,750
Capacity, ultimate, hp	12,000
Capacity comp. air, present, cu.ft. per min	140,000
Capacity comp.air, ultimate,cu.ft.per min.	210,000
Boiler house, ft	165x68
Turbine, room, ft	200x93
Consulting mechanical engineer	Will J. Sando

BOILERS AND SUPERHEATERS

Manufacturer	Heine Boiler Co.
Type	Back cross-drum, water tube
Number installed	4
Steam-making surface per boiler, sq.ft.	7,840
Grate area, sq.ft	114.8
Ratio steam-making surface to grate area	68 to 1
Furnace volume, cu.ft	1,850
Furnace volume, cu.ft. per sq.ft. of steam making surface	0.236
Tubes, 3½ in., 18 ft. long, number	418
Boiler pressure, lb. gage	225
Steam temperature, deg. F	532
Superheat, deg. F	135
Superheater (Foster)	Power Specialty Co.
Surface, sq.ft	1,572
Ratio superheating to steam-making surface	1 to 5
Location	Above first and second pass

FUEL

Kind	Western bituminous run of mine
Heat value, B.t.u. per lb	10,500 to 12,500

STOKERS

Manufacturer	Westinghouse Elec. & Mfg. Co.
Type	Underfeed, seven retort
Effective grate area, sq. ft	114.8
Ratio steam-making surface to grate area	68 to 1
Stoker drive	3 to 7 hp. vertical Engberg engine

FORCED-DRAFT EQUIPMENT

Manufacturer	B. F. Sturtevant Co.
Number of fans	4
Type	No. 75 turbovane
Capacity of fan, cu.ft. per min	21,700
Drive	40 hp. Sturtevant turbine
Control	Pressure governor

INDUCED-DRAFT FANS

Manufacturer	B. F. Sturtevant Co.
Number of fans	2
Type	Multivane
Capacity per fan, cu.ft. per min	53,330
Drive	50 hp. Sturtevant vertical engine

ECONOMIZERS

Manufacturer	B. F. Sturtevant Co.
Number	2
Effective surface, sq.ft	8,500
Ratio economizer surface to steam-making surface, per cent	54

CHIMNEY

Erected by	Alphons Custodis Chimney Construction Co.
Material	Rectangular brick matching building
Height above grate, ft	220
Diameter at top, ft	12
How supported	Concrete block on piles

BOILER-FEED PUMPS

Manufacturer: Allis-Chalmers Mfg. Co.
Two 3-in. low-lift, single-stage centrifugal, motor-driven, 25 hp.
Two 3-in. high-lift, 5-stage centrifugal, motor-driven, 125 hp.
One 3-in. high-lift, 6-stage centrifugal, turbine-driven, 125 hp.

HEATERS

Manufacturer	Cochrane Corp.
Number and type	2 open multi-feed
Capacity of each, lb. per hr.	150,000

WATER-SOFTENING PLANT

Manufacturer	Wayne Tank & Pump Co.
3 vertical pressure filters, size, in.	96x48
Capacity of each, lb. per hr.	140,000
2 water softeners, zeolite process, size, in.	96x60
Capacity of each, lb. per hr.	140,000

HEATING SYSTEM

Manufacturer	Warren Webster & Co.
Type	Two-pipe vacuum system
Radiation, sq.ft.	28,000
Pump and receiver outfit, aut. control of air and condensation	Nash Engineering Co.
Thermostatic control	Johnson Service Co.

COAL HANDLING

Furnished by	Chain Belt Co.
Reciprocating feeder, double type, 30-in. wide	
Magnetic pulley with bulb, 30 in. wide	Cutler-Hammer Mfg. Co.
Crusher, single-roll, motor-drive, 30 hp.	Jeffrey Mfg. Co.
Bucket elevator, lift center to center, ft	88
Bucket elevator, speed, ft. per min.	110
Belt conveyor, automatic tripper, length between centers, ft	90
Belt conveyor, speed, ft. per min.	200
Capacity system, tons per hour	35
Drive	440-volt, 3-phase induction motor
Push-button control	Cutler-Hammer Mfg. Co.
Bunker, steel parabolic concrete-lined, tons	650
Automatic coal scales, four 200 lb. each	Richardson Scale Co.

ASH HANDLING

Ash storage per boiler hopper, cu.ft.	250
Gates, 3x3 ft., operated by ratchet lever	Baker Dunbar Co.
Steam-jet systems, ash and soot	Conveyor's Corp. of America

MAIN GENERATING UNITS

Manufacturer	Allis-Chalmer Mfg. Co.
Number of units	3
Capacity, 80 per cent power factor, kw	625
Speed of unit, r.p.m.	3,600
Throttle pressure and superheat, lb. gage and deg. F.	200-130
Type of generator	3-phase, 60-cycle, 440-volt
Exciter, direct connected, kw	9
Condenser, jet, capacity, lb. per hr.	10,750
Removal pump, centrifugal, gal. per min.	1,000
Drive Induction motor, hp. 20, r.p.m. 1,150	1,150
Vacuum pump, R.D.V., size, in.	5x15x12
Oil-filter pump	Motor-driven, hp. ½, r.p.m. 1,250
Oil filter each unit	S. F. Bowser & Co., Inc.
Switchboard, 16 panels	Allis-Chalmers Mfg. Co.

TURBO-BLOWER UNITS

Supplied by	Allis-Chalmers Mfg. Co.
Number of units	4
Capacity of each, 10 lb. air press., cu.ft. per min.	30,000
Speed, r.p.m.	3,600
Turbine throttle press. and superheat, lb. gage and deg. F.	200-130
Blower, 3-stage	Ingersoll-Rand Co.
Air washer, water spray, 30,000 cu.ft. per min.	Spray Engineering Co.
Washer pump, motor-driven, 10 hp., gal. per min.	300
Condenser, jet type, capacity, lb. per hr.	18,350
Removal pump, centrifugal, gal. per min.	1,700
Drive	Induction motor, hp. 30, r.p.m. 1,150
Vacuum pump, R.D.V. size, in.	7x18x15
Oil-filter pump	Motor-driven, hp. ½, r.p.m. 1,200
Oil filter each unit	S. F. Bowser & Co., Inc.

MAIN LOW-LIFT PUMPS

Manufacturer	Allis-Chalmers Mfg. Co.
Number of pumps	3
Type	Single-stage, vertical shaft
Capacity of each, gal. per day against 35 ft. head	30,000,000
Drive, induction motor, 3-speed, aut. control, hp.	250
Full speed, r.p.m.	390

SLUDGE RETURN PUMPS

Manufacturer	Allis-Chalmers Mfg. Co.
Number of pumps	3
Type	Single-stage, double-suction, vertical-shaft
Capacity of each, gal. per day	12,000,000
Drive, induction motor, var. speed, aut. control, hp.	50
Full speed, r.p.m.	385

MISCELLANEOUS EQUIPMENT

Station crane, 20-ton, 3-motor	Milwaukee Electric Crane Co.
Gland water pumps, two, motor-driven	Union Steam Pump Co.
Soot blowers	Diamond Power Specialty Co.
Balanced draft system	The Engineer Co.
Feed-water regulators, Copes	Northern Equipment Co.
Blowoff valves	Edward Valve & Mfg. Co.
Safety valves, consolidated	Manning, Maxwell & Moore, Inc.
Boiler non-return valves	Edward Valve & Mfg. Co.
Throttle valves	Edward Valve & Mfg. Co.
High-pressure steam valves	Edward Valve & Mfg. Co.
High-pressure steam valves	Chapman Valve Mfg. Co.
Low-pressure water valves	Chapman Valve Mfg. Co.
Atmospheric relief valves	Klipfel Mfg. Co.
Steam separators, Stratton	Griscom-Russell Co.
Steam traps	Boylston Steam Specialty Co.
Water columns	Reliance Gauge Column Co.
Flow meters, feed water	General Electric Co.
Flow meters, steam	General Electric Co.
Co_2 recorder, multiple unit	Uehling Instrument Co.
Steam-pressure gages	The Foxboro Co., Inc.
Draft gages, multi-pointer	The Foxboro Co., Inc.
Recording thermometers	The Foxboro Co., Inc.
Boiler Baffles, Turner	The Engineer Co.
Steel sash	Crittall Casement and Window Co.
Sash operators	Olmey Dean Co.
Steel doors	Central Metal Products Co.
Gratings for operating floor	Wm. F. Klep Co.

well as large volumes of air, it obviously becomes necessary to provide a venting arrangement for the tank to prevent the piling up of back pressure. This exhaust carries with it a large amount of fine dust, and to prevent the discharge of this dust to the atmosphere the tank is equipped with a dust-eliminating vent. This is a combination of baffling and water-spray equipment which deposits the dust in two accumulating chambers in the bottom of the eliminator, from which point the sludge is drained off into a sludge trap and removed at intervals.

Coal is delivered on a railway siding having a double-compartment track hopper and reciprocating feeder which delivers through a single-roll crusher to a positive-discharge bucket elevator from which the coal is transferred to a belt conveyor with an automatic tripper passing over a parabolic, overhead, steel bunker. The capacity of the system is 35 tons of coal an hour. All equipment is driven by 440-volt three-phase induction motors under push-button control from three stations—one at the crusher, the second on the firing floor and the third at the belt conveyor level above the bunker. From the overhead bunker coal is delivered to the stokers through individual automatic scales.

Handling the Boiler Feed

River water is used for boiler feed, and as much of this feed is raw water, owing to the use of jet condensers, it was deemed advisable to install a complete water-softening plant. This consists of three vertical rapid-rate water filters, each having a capacity of 140,000 lb. per hour and two water softeners using the zeolite process. For the present it was not considered necessary to build sedimentation tanks for preliminary treatment of the river water, as it is anticipated that the water will be clarified sufficiently by the over-capacity of filters provided.

Either one of two single-stage, low-lift, motor-driven centrifugal pumps passes the river water through the treating plant to the feed-water heaters, of which there are two of the open type, each having a capacity to heat 150,000 lb. of water per hour. These heaters are mounted on concrete bases 10 ft. high to give a proper head on the boiler-feed pumps. There are three of these pumps, two having five stages and motor-driven, and one having six stages and operated by a steam turbine. In passing the feed water through the economizers to the boilers, these pumps may be used interchangeably. Feed-water regulators at the boilers and governors at the pumps control the rate of feed to the individual boilers.

It will be noticed that with the exception of the two low-lift pumps, two of the boiler-feed pumps and the coal-handling equipment, the auxiliaries in the boiler room are steam driven, this applying to the forced- and induced-draft fans, the stokers, one of the boiler-feed pumps and the steam-jet ash system. Careful planning in auxiliary drive was necessary, as during eight months of the year considerable steam is required for heating the various buildings of the works as well as the boiler-feed water all the time. The entire heating system has 28,000 sq.ft. of direct radiation, and for the most part exhaust steam will be used, with provision for supplementing with live steam.

The main high-pressure steam piping in the plant is straightforward, and ample provision has been made for expansion. From the superheater of each boiler, an 8-in. lead with an expansion loop drops down into the 14-in. main header under the operating floor. The main supply line to the turbine room, which is 12 in. in diameter, takes off from this header and is suspended under the walkway running down the center of turbine room as previously explained. In this long run, a large double U expansion loop turning upward is provided. Welded steel piping with steel flanges and valves is used in all high-pressure work. A feature of the water piping is the fact that it is either brass or galvanized iron for protection against corrosion.

Operation of the boilers has been made as nearly automatic as possible. A balanced-draft system controls the position of the damper and the speed of the stoker engine. Pressure governors regulate the turbines driving the forced-draft fans, and pump governors on the boiler-feed pumps with automatic regulators at the boilers control the flow of feed water.

Each boiler has a steam-flow meter mounted on a building column at the front corner of the boiler setting, and below it is a gage panel containing a steam-pressure gage, a multi-pointer draft gage giving the draft pressure in the furnaces, at the uptake and in the windbox, and a recording thermometer giving the flue-gas temperature. A totalizing electric flow meter records the steam supply to the turbine-room, flow meters measure the feed water and, as previously stated, each boiler has its individual automatic coal scale and check revolution counters have been placed on the stoker engines. To show the combustion efficiency, a multiple-unit CO_2 equipment is centrally located between the two batteries of boilers. It contains recording and indicating units for each boiler.

In a project of such magnitude it was not considered an economic waste to spend a reasonable amount of money on appearances. With the aid of an Advisory Board of Architects the power plant was made one of the show places of the city. The side walls have large glass areas, and monitor roofs provide additional light and ventilation. The construction is of structural steel, skeleton-frame type, with columns in the power house encased in brick masonry. The exterior of the building has been faced with a golden tan brick in rough texture mixed with a darker brick to give the walls a pleasing shade, the colors ranging from a light tan to a golden buff, with sufficient dark shades. On the interior the walls have been finished with cream-colored smooth-face brick. The floors in the turbine room and portions of the boiler room are of red quarry tile, laid up with natural cement joints. The machinery foundations are of concrete and are faced with a cream-colored mosaic to harmonize with the interior brickwork.

The building contains a complete two-pipe vacuum heating system under thermostatic control, with a pump and receiver outfit automatically caring for air and condensation. Radiators are placed along the sides of the turbine room near the floor and also along the vertical lower section of the monitor roof. The latter location was selected to provide proper air circulation to prevent roof condensation, an additional safeguard being five-ply asbestos roofing on a wood base.

The design and construction of the entire power plant and machinery equipment for the works has been under the direct supervision of the Sewerage Commission of the City of Milwaukee, of which George P. Miller is chairman, T. Chalkley Hatton, chief engineer, and Will J. Sando, consulting mechanical engineer.

Grounding Transformer Secondaries

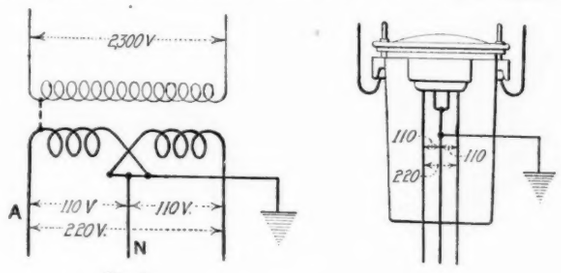
By J. B. GIBBS
Transformer Engineer, Westinghouse Electric & Manufacturing Company

IN THE use of transformers to supply power from a high- to a low-voltage system there is always the possibility that an accident may bring a primary line into contact with a secondary line. If the secondary line is free to assume the voltage above ground of the primary, a dangerous condition is created. The insulation of the wires used in buildings is not designed for such voltages, and a breakdown may occur, followed by an arc, that will start a fire. Or a person coming in contact with the low-voltage line may furnish a path to ground and receive a fatal shock.

If the secondary system is grounded, however, such accidents are impossible. Fig. 1 shows a diagram of a distribution transformer connected for the usual three-wire single-phase service, such as used for lighting. The neutral wire *N* is grounded. If the primary should come into contact with the secondary, as shown by the dotted line in the figure, no damage would be done except blowing the primary fuses. If the fuses did not blow, the voltage from *A* to *N* would be limited to 110 volts with an ungrounded primary and the point *N* solidly grounded. Therefore, the maximum voltage of *A* above ground is 110 volts. This plan decreases the fire hazard as well as the life hazard of electric service. Also, since a cross between primary and secondary causes a ground on the primary line, an immediate indication of the trouble can be given at the power house or substation.

For these reasons the secondaries of transformers used for lighting or for low-voltage motors are grounded. The National Board of Fire Underwriters gives complete rules for grounding distribution transformers and also interior wiring systems.[1] Some of the principal rules concerning grounding of transformer secondaries are as follows:

The ground connection shall be so arranged that under normal conditions there will be no appreciable current in the grounding conductor.



Figs. 1 and 2—Ground connection on secondary of single-phase transformer supplying a 3-wire system

Artificial grounds, such as buried plates, driven pipes or rods, shall be embedded below permanent moisture level where practicable. Each ground must present not less than 2 sq.ft. of surface to the exterior soil. Copper ground plates shall be at least 0.06 in. thick. Ground plates of iron shall be at least 0.25 in. thick. Ground pipes of iron or steel which are driven into the ground shall be not less than ¾ in. outside diameter. Other approved ground rods must be not less than ½ in. diameter.

If a system grounding wire is used, it must be effectually grounded at intervals that will satisfy the requirements given below as to resistance and current-carrying capacity.

The combined resistance of the grounding wire and the connection to ground shall not exceed 3 ohms for water-pipe connections, nor 25 ohms for buried or driven grounds. If one artificial ground cannot be made to give a resistance as low as 25 ohms, this requirement shall be waived and two artificial grounds, at least 6 ft. apart and with a combined area of not less than 4 sq.ft., shall be used.

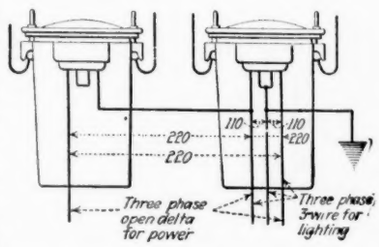


Fig. 3—Ground connection on one transformer of two grouped in open-delta

Direct-current overhead distribution systems must be grounded if the maximum potential above ground does not exceed 300 volts.

Alternating-current systems must be grounded if the voltage above ground does not exceed 150 volts, and it is recommended that such systems be grounded if the voltage above ground lies between 150 and 300 volts.

In alternating-current systems the connection to the ground shall be made at each service before connecting to the line. By special permission of the Inspection Department, however, the ground connection may be made at the transformer or to a system ground wire.

In single-phase two-wire alternating-current systems either conductor may be grounded. In single-phase three-wire systems the neutral must be grounded. In two-phase or three-phase systems the point to be grounded should be selected so as to give the lowest voltage from live conductors to ground.

If one phase of a two-phase or three-phase system is to be used for lighting, that phase must be grounded, preferably at its neutral point.

Where several transformers supply a common set of mains, any fuses that may be installed must be placed so that no part of the secondary system is without ground protection if the fuses are blown.

Grounding conductors must be of copper and, if practicable, without splice or joint.

Ground wires must be protected from mechanical injury. Lightning arrester grounds must be protected by non-magnetic material or else solidly connected at both ends to the protective covering.

The path to ground must have an ampere capacity sufficient to insure its continued effectiveness when any point of the system is grounded.

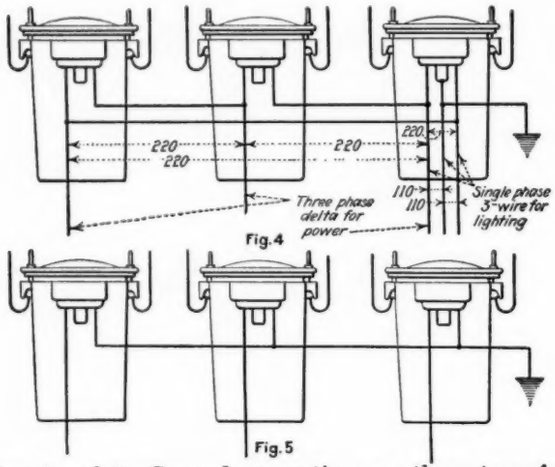
The grounding conductor for alternating-current systems must have a capacity not less than one-fifth that of the conductor to which it is attached, except that it must be at least No. 8 and need not exceed No. 0.

The conductor grounding a lightning arrester must

[1] See the National Electrical Code issued by the National Board of Fire Underwriters.

not be connected to the same artificial ground as the circuit, but must be separately grounded at least 20 ft. away if practicable. It must have a current-carrying capacity sufficient to insure its effectiveness under conditions of excess current caused by or following the discharge. It must not be smaller than No. 6 wire.

At supply stations grounding conductors must be connected to all available buried piping systems which are



Figs. 4 and 5—Ground connections on three transformers grouped closed-delta and in star

normally at the same potential. Elsewhere the grounding conductor must be connected to one such system if available. The most desirable ground is one to a system of water piping. Grounds to gas piping should be avoided. They may be permitted under certain conditions for use as grounds for equipment. Where no piping system is available, other grounds are permitted.

Additional rules are given covering the grounding of the wiring and equipment in buildings. These rules are intended to make electric service safe to the user, and they should be carefully followed.

Figs. 2 to 5 show various transformer connections and indicate the lead that should be grounded. For simplicity the figures show the grounds made at the transformer. The N.E. code rules allow this when special permission is obtained, but otherwise require that the ground connection be made at each service. Fig. 2 shows the usual single-phase three-wire connection with the neutral grounded. Fig. 3 shows two transformers connected in open-dalta for supplying three-phase power to 220-volt motors. One of the transformers is also connected to three-wire lighting mains, and this transformer is grounded at its neutral point. Fig. 4 shows three transformers connected in delta with one of them carrying a single-phase three-wire lighting system. Fig. 5 shows three transformers connected in star with the neutral point grounded. No lighting system is shown in this figure, because this connection is used rarely if ever with small transformers. Standard distribution transformers have normal secondary voltages of 115, 230 or 460 volts. If these secondaries are connected in star, the voltage between secondary lines will be 1.732 times the transformer voltage. This is an odd voltage and does not correspond to standard motors or lamps.

The foregoing may be summarized by saying that the solid connection to ground of some point of the low-voltage system is the only means of preventing the possibility of dangerous voltages on such a system.

Operating a Diesel Power Plant

By Robert G. Melrose

There are instances where observation of running conditions of a Diesel engine suggests to the operator minor adjustments wherewith the efficiency of the engine may be increased. Likewise, there are times when, owing to some objectionable condition making itself manifest with scant warning, presence of mind and quick action are imperative to avert damage, if not total breakdown. An engine, after running quietly for a long time, may develop without warning a number of peculiarities, such as strange noises in the cylinder, slowing down without apparent cause, excessive smoking at the exhaust, misfiring, etc., some of which can be rectified by minor adjustments.

The following examples have been culled from personal experience of various classes of heavy-oil engines, all working on the Diesel principle, and may tend to explain the cause of undesirable conditions, thus enabling the engineer to recognize the symptoms and take steps accordingly.

Noises in the cylinder may be caused by a broken ring and can be verified by listening at the crankcase inspection door. The broken part gives out a sharp clicking noise as the engine passes the bottom center. It need not be considered a dangerous defect in a four-stroke-cycle engine, but in a two-stroke-cycle engine it may be followed by complications, due to the broken ring catching in the exhaust or scavenging ports. A sharp grunt in the cylinder is generally a sign of a seized piston. If not immediately attended to, the noise develops, producing a concussion that seems to shake the whole engine room. As soon as the pounding occurs, the operator should shut off the fuel and blast-air lines of that cylinder and by means of the hand attachment on the cylinder lubricator, pump in a plentiful supply of oil. If the decompression gear of the cylinder can be adjusted independently, it should be set to break the compression and thus further reduce the temperature. On no account should the piston cooling-water supply be increased at this juncture, as this procedure will probably crack the piston, but after waiting a reasonable time the cooling water may be increased and the cylinder cut into action again. On investigation it is generally found that the overheating has been caused by a too meager supply of piston cooling water or perhaps a stoppage due to silting up of the water passages.

In one instance a hot piston was hurriedly cooled by increasing the cooling-water supply. Shortly after this was done, smoke was observed emerging from the piston water discharge pipe, indicating a cracked piston.

A noise in the nature of a detonation may be caused through preignition and, if very bad, will be accompanied by the lifting of the relief valve. This condition must not be confused with the results caused by a broken or badly leaking fuel valve, which will also cause the relief valve to lift owing to the excessive accumulation in the cylinder of high-pressure blast air. A tightly packed fuel-valve spindle may produce the same results owing to the sticking of the spindle and the spring being unable to reseat the valve, but these conditions produce other symptoms which cannot fail to come to the notice of the engineer in charge, such as lowering of the blast-air pressure and ultimate stoppage of the engine.

An engineer soon becomes accustomed to the various sounds given off by the valve gear and can tell at a glance by the vibration of the spring if the valve is reseating properly; it is a common occurrence for the nuts on the valve lever to slack back owing to vibration and cause one of the valves, either the air inlet or exhaust valve, to remain slightly open, thus destroying the compression and causing misfiring. With a slow-speed engine this defect can be adjusted temporarily without stopping the engine, but the operation should be attended to with discretion in the case of a high-speed engine.

Looking to the Fuel Pump

Misfiring may also be caused through some defect in the fuel pump whereby an insufficient supply of oil is delivered to the fuel valve, but this is an uncommon occurrence unless the manufacturer's settings have been altered, and any deficiency in the output of the pump will probably trace to an air lock. Fuel pumps in modern engines are generally fitted with two discharge valves, and it is seldom that both valves will be held off their seats at the same time by dirt. In many installations the oil flows to the fuel pump by gravity after first passing through strainers. The strainers are in duplicate with a two-way clock on the connecting pipe so that in the event of one strainer becoming clogged with dirt the oil can be immediately turned through the other one, and service without cleaning will, of course, restrict the flow of oil to the fuel pump, but this affects the entire pump.

Leaking fuel-pump glands are now practically a thing of the past unless the job has been attended to by an incompetent person; with some of the early solid-injection engines, where the pumps had to contend with a pressure of from 3,000 to 4,000 lb. per square inch, it required all the skill of the engineer to keep the gland tight and at the same time refrain from scoring the pump plunger by excessive screwing up of the packing gland.

A properly tuned engine should run with only a slight haze showing at the exhaust pipe, but where the load fluctuates very much this desirable condition is sometimes difficult to attain. With air-injection engines the blast-air pressure and the lift and time of opening of the fuel valve are assumed to remain constant; however, if the load falls off, the governor takes care of the speed by decreasing the oil supply to the fuel valve, thus removing part of the obstruction to the ingress of blast air, consequently there is a surplus of air. This is made manifest by a white smoke at the exhaust pipe. Should the light-load condition continue, this increased flow of blast air tends to reduce the blast pressure, and should the load come on suddenly again, the blast pressure is not high enough to atomize the oil properly, with the result that black smoke is produced, denoting incomplete combustion and deposit of carbon.

Valve settings play quite an important part, and the clearances should be tested and adjusted, if necessary, periodically, as a surprising alteration sometimes takes place after the engine has been running for some time.

Smoking at the exhaust pipe in a two-stroke-cycle engine may be caused by scavenging turbulence, a condition generally confined to high-speed engines, where the limited time allowed for the efficient expulsion of the burnt gases by the scavenging air is productive of high air velocities. The solution of this problem is at present a debatable point, but it is generally conceded that the high-velocity air has a tendency to create eddy currents in the cylinder and the burnt gases are merely circulated in the cylinder and not properly expelled. Turbulence is sometimes the result of supercharging, that is, increasing the pressure of the scavenging air, which in conjunction with an increased fuel supply is a method resorted to in order to increase the output of the engine.

In most installations the piston-cooling and jacket-cooling systems are separate, the piston-cooling water pressure ranging from 25 to 40 lb. per sq.in. and the jacket and head pressure at 10 to 15 lb., the air-compressor cooling water being tapped off the latter supply. The water enters the jacket near the bottom and leaves it at the top to enter the cylinder head, from there flowing to the exhaust manifold. Attempting to increase the thermal efficiency of the engine by cutting down the cooling-water supply is a doubtful procedure if carried beyond rational limits and has been the cause of many cracked cylinder heads. The temperature may have been finely adjusted when the engine was running light, and on the load increasing the attention of the operator may be otherwise engaged, with the result that the temperature of the cylinder head rises considerably before he is aware of the fact, and on opening the pet cocks on the cylinder head outlet steam instead of water blows out. The procedure is to leave the pet cocks open and very cautiously open the regulating valves, thus cooling the heads gradually until water is observed issuing from the pet cocks and shut them.

Guard Against Water in Cylinder

Cylinder heads have been retained in service even when known to be cracked, but special care must be taken when starting up if the engine has been at rest for some time, as water may have found its way into the cylinder. The safest procedure is to open the indicator cocks and turn the engine a few revolutions.

The following instance may serve to illustrate more forcibly the desirability of carrying out this procedure: The installation consisted of an eight-cylinder, solid-injection, trunk-type engine direct connected to a generator, and had been shut down only a few hours when a sudden call on the resources of the plant necessitated its being started up immediately. The few revolutions by means of the turning gear were dispensed with and the engine was started by utilizing the generator as a motor until the cylinders started firing. Before a revolution had been completed, a loud knock was heard, accompanied by a jar and the appearance of water at one of the relief valves. The engine was stopped, and after an examination the extent of the damage was found to be a bent connecting rod and a broken piston skirt. As the engine was wanted badly, the valve gear was immediately dismantled, the cylinder head removed, the connecting-rod bottom bearing taken apart and the piston and connecting rod withdrawn. The oil holes and water connections were plugged and gagged, fuel shut off to that cylinder and the engine started up again. On examining the cylinder head a crack was found extending from the fuel to the exhaust valve opening.

In the article entitled "Fuel Oils for Diesel Engines" appearing in *Power*, Aug. 5, the word "kohlenwasserstoffen" in the original text was translated as *carbohydrate* when the real meaning is *hydro-carbon*.

Tests of Mechanical Soot Blowers

By ROBERT JUNE*

BECAUSE of the many variables it is difficult to determine the savings effected by mechanical soot blowers as evidenced by reductions in flue-gas temperature. The following tests are believed to be among the most comprehensive and thorough that have been made and are of particular interest in that they confirm some of the general claims that have been made from a strictly fuel-saving point of view.

Test on Oil Fired Boiler

The following test was made by a prominent boiler manufacturer on a horizontal water-tube boiler. The objective of the several test runs were:

1. To compare the efficiency of the soot blowers with ordinary steam hand lances for removing dirt from the horizontal circulating tubes. All the soot-blower elements were equipped with valve-in-head type of revolving heads, thus allowing steam to flow only when the element was pointed in the proper direction.

One set of tests was run at a combustion rate of 0.35 lb. of oil per square foot per hour and a second set at 0.75 lb. per square foot per hour. Readings were first taken on all of the instruments that we were interested in, the CO_2 at the top of the second pass being held at 14 per cent and the steaming being held at either the 0.35-lb. or the 0.75-lb. rate. After a few readings had been secured to show that conditions were steady, the tubes were thoroughly blown.

During the interval when the tubes were blown, a slight excess of air was used in the burners so that

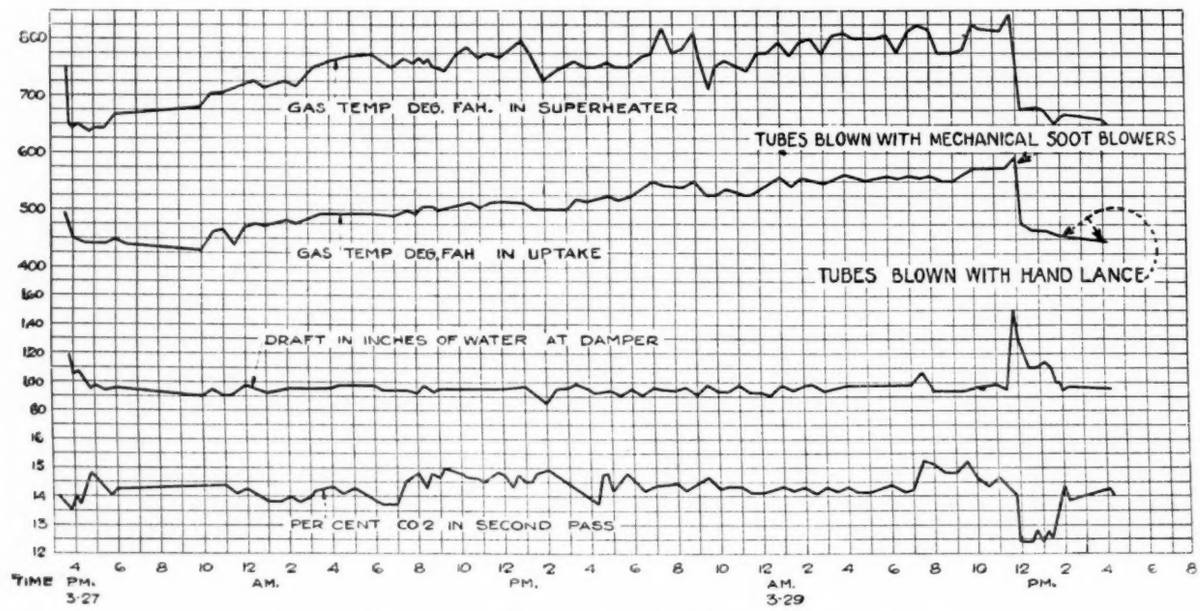


Fig. 1—Gas temperatures, draft and CO_2 during 48-hour run

boiler tubes. The determination of relative efficiencies was to be based on the uptake gas temperatures obtained after comparative blowings with the two systems when all temperature conditions were steady around the boiler and 14 per cent CO_2 was being maintained in the uptake gases.

2. To determine the relative efficiencies of a set of mechanical soot blowers fitted with elements having narrow-spaced nozzles and another set similarly located, having wide-spaced nozzles.

The boiler was of the marine type vertically baffled and having 2,140 sq.ft. of heating surface. Soot blowers were located in the usual way in the three boiler passes and in the superheater. The "A" location element, namely, the soot blower located against the front header at the bottom of the first pass above the bottom row of tubes, was fitted with protecting barriers. Pyrometer gas-temperature readings were taken in the superheater and at the boiler uptake immediately above there would be no tendency to produce smoke due to the presence of the jets of steam in the boiler passes. As soon after blowing as possible, conditions were brought back to 14 per cent CO_2 and held there long enough to obtain check readings, after which a definite amount of smoke, between $\frac{3}{4}$ and $1\frac{1}{2}$ on the smoke-density chart, was purposely made so as to foul the tubes within a reasonable period. This deliberate making of smoke produced a very high CO_2.

The boiler was allowed to continue under these conditions until the temperature of the gases at the uptake had increased approximately 100 deg. above that existing immediately after the tubes had been dusted at the start of the test. The CO_2 was then brought back to 14 per cent in the second pass and held there long enough to obtain check readings. Lowering the CO_2 in the gases to 14 per cent increased the temperature of the gases at both points.

Immediately after obtaining a series of check readings with 14 per cent CO_2, the tubes were thoroughly

*Robert June Management Organization, Detroit.

dusted either with a hand lance or with mechanical soot blowers, conditions again brought to 14 per cent CO_2, and a series of check readings taken. The tubes

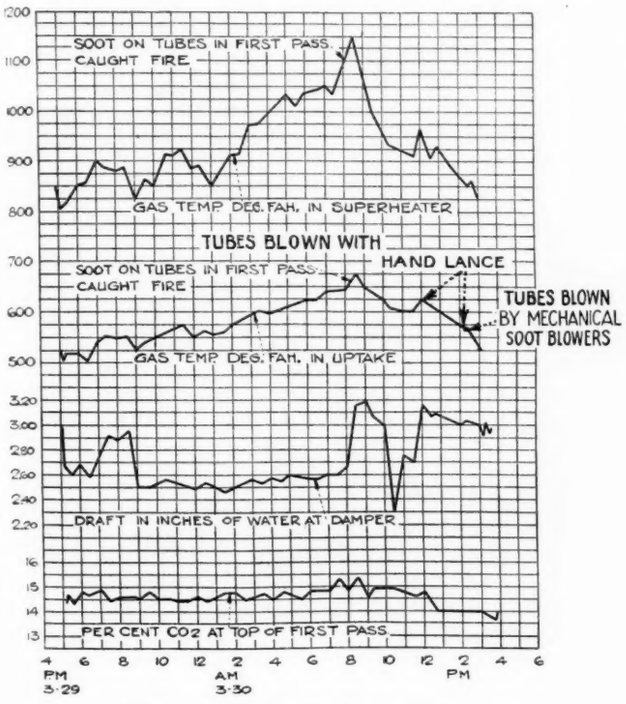

SOOT ON TUBES IN FIRST PASS CAUGHT FIRE
GAS TEMP DEG. FAH. IN SUPERHEATER
TUBES BLOWN WITH HAND LANCE
SOOT ON TUBES IN FIRST PASS CAUGHT FIRE
TUBES BLOWN BY MECHANICAL SOOT BLOWERS
GAS TEMP DEG. FAH. IN UPTAKE
DRAFT IN INCHES OF WATER AT DAMPER
PER CENT CO2 AT TOP OF FIRST PASS
PM 3-29
AM 3-30
PM

Fig. 2—Events during 24-hour run

were then again dusted with either the hand lance or the soot blowers, the second method being the opposite of that first used, and following this second blowing check readings were again taken at 14 per cent CO_2, at the end of which time the test was regarded as finished.

On the afternoon of Mar. 27 the first test was started, the boiler being operated at the 0.35-lb. rate. Fig. 1 shows in graphical form the events that took place during the next 48 hours. The curves show the gas temperature in the superheater, the gas temperature in the uptake, the draft in inches of water carried at the boiler damper and the percentage of CO_2 at the top of the second pass.

It may be noted that shortly before 12 o'clock on the morning of Mar. 29 the CO_2 was brought back to 14 lb. and the tubes then dusted with the soot blowers. This had the effect of dropping the temperature of the gases in the uptake from 590 to 455 deg., this being about 10 deg. above where they started some 46 hours previously. Check records under these conditions being obtained by 2 o'clock in the afternoon, the boiler was then thoroughly dusted with hand lances, this job taking nearly two hours. The result of this hand lancing was to reduce the temperature of the gases in the uptake another 5 deg., thus finishing up at exactly 450 deg. at the end of the test.

Following the completion of the test at 4 o'clock the steaming was increased to the 0.75-lb. rate and at 5 o'clock check readings were secured at 14 per cent CO_2. Following this the CO_2 was increased to over 14½ per cent, producing a fairly heavy smoke, and these conditions were maintained throughout the night. Fig. 2 shows in graphical form the events that took place during the next 24 hours.

The following morning around 8 o'clock it was felt that the smoke was a little too heavy to represent any but the worst of service conditions, and accordingly the draft was increased a little with the idea of reducing the smoke. The effect of this was interesting, as immediately the soot on the tubes throughout the boiler caught fire, cleaning off a large amount and temporarily giving high gas temperatures. After the soot had burned itself out, the gas temperatures were much lower than they had been at 7 o'clock that same morning under the same draft and CO_2 conditions.

Fig. 3—Average temperature of 481 degrees maintained with soot blowers in use

At 11 o'clock in the morning of the 30th it was

noticed that the gas temperature at the uptake was approximately 100 deg. higher than it had been at the start the previous afternoon, and accordingly the CO_2 was brought to 14 per cent and a series of check readings obtained, these being satisfactorily secured a little before 1 o'clock in the afternoon. The boiler was then thoroughly dusted with the hand lances, this dusting taking over one and one-half hours and reducing the temperature of the gases at the uptake from 615 to 560 degrees.

After securing check readings under the foregoing conditions at 2:30 p.m., the soot blowers were used to give the boiler a dusting, following which the CO_2 was again brought to 14 per cent and it was observed that the gas temperatures had taken a further appreciable drop, that in the uptake coming from 560 to 520 deg. This latter was approximately the same as existed at the start of the test.

This test, the results of which are shown in Fig. 3, was conducted by a public utility company for its own guidance on a 6,500-sq.ft. Bigelow-Hornsby boiler. The duration of each run was 24 hours, and at the beginning of each run the fire was cleaned and the hopper filled. The tail gate was cleaned whenever found necessary by observation of the fire. This varied from every two to four hours, depending on the load. Six runs in all were made, the first three with soot blowers and the second three without soot blowers, attempting to reproduce the conditions of the first three as nearly as possible. In doing this the fireroom crew and the tester were guided by the average conditions attained in the first three runs. Readings were taken every twenty minutes. The steam utilized by the soot blowers was not registered by the steam-flow meters. Readings were taken as follows: Steam flow; air flow; furnace draft gage; windbox pressure; the speed of the stoker line shaft; the number of revolutions of the stoker power shaft; steam temperature; feed-water temperature; flue-gas temperature on three pyrometers; cold-junction temperature; air temperature; steam pressure and carbon dioxide in the flue gas. Forced draft was obtained from No. 3 blower, which was isolated from the other blowers by closing the division damper. It was kept running throughout the entire test, and the draft to the boiler was regulated by means of the control at the boiler.

The average value of the flue-gas temperature for the series with soot blowers is 481.0 deg. F., against 569.0 deg. F. without soot blowers. This represents a decrease of eighty-eight degrees using soot blowers and means that with the soot blowers in operation the boiler has absorbed more heat from the gases, due to cleaner heating surfaces, than without soot blowers.

Test on 12,000-Square Foot Boilers

This test was conducted by a large mid-western central station. The results are shown in Fig. 4. It will be seen that the test covered a period of nearly two months. During this time the boiler was operated in as nearly a uniform manner as possible. For thirty days without soot being blown, the temperature of the gases leaving the boiler increased from 485 to nearly 700 deg. The first soot-blowing operation brought the temperature to less than 600 deg., and when the soot blowers were again operated twelve hours later, the flue-gas temperature was brought down to 550 deg., at which point it was thereafter maintained.

The operating department of this public utility has furnished the following data on soot blower operations and savings effected thereby:

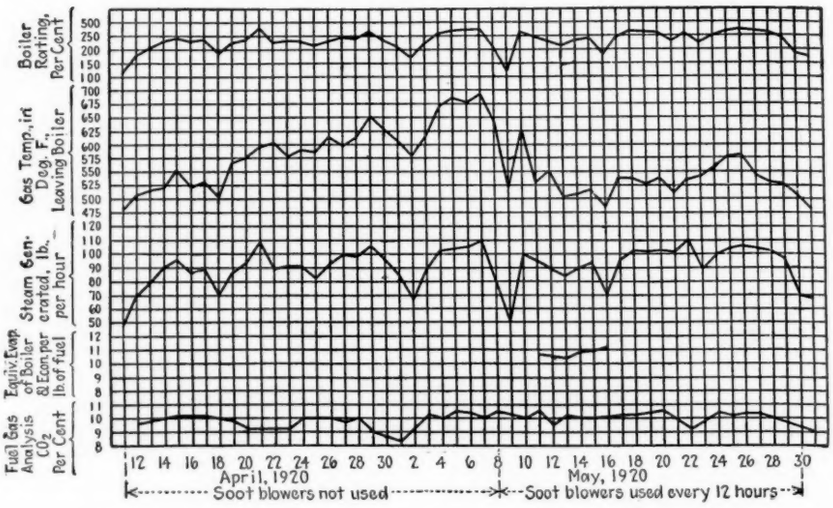

Boiler Rating, Per Cent
Gas Temp. in Deg. F. Leaving Boiler
Steam Gen. crated, lb. per hour
Equiv. Evap. of Boiler lb. Eco. per lb. of fuel
Fuel Gas Analysis CO_2 Per Cent
12 14 16 18 20 22 24 26 28 30 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
April, 1920
May, 1920
Soot blowers not used
Soot blowers used every 12 hours

Fig. 4—Two months' test with and without soot blowing

Steam per day for soot blowers per boiler	16,500 lb.
Number of boilers	8
Total steam per day	132,000 lb.
Lb. steam per pound of coal	8.0
Coal required for generating steam	16,500 lb.
Average pounds of steam generated per day	11,000,000
Steam required by soot blowers	1.2 per cent
Cost of coal per ton	$5.50
Total cost of coal	$45.37
Average daily cost of repairs, inspection, operation and maintenance	$10.30
Approximate total cost per day	$55.70
Total coal burned daily	750 tons
Coal equivalent to $55.70 (approx.)	10.2 tons
Temperature of gases leaving boiler (present operation)	545 deg. F
Heat of fuel present in flue gas at 545 deg. F. (approximately)	15.0 per cen
Heat of fuel present in flue gas at 600 deg. F (approximately)	17.0 per cen
Saving due to keeping flue-gas temperature low	2 per cent
Fuel saved at plant due to low gas temperature	15 tons

Predicting Fatigue in Metals

While the actual explanation of the failure of metals due to the prolonged or periodic action of forces, has yet to be given, valuable results have come from the investigations so far made, and certain generalizations are permissible, according to Prof. C. F. Jenkin of the University of Oxford in an address before the British Association for the Advancement of Science. The studies have been placed on a mathematical basis, so that it is possible to derive a formula for the manner in which a fatigue crack extends, once it has started. It has also been possible to relate the line along which the cracking takes place with the direction in which the principal stress causing it has been acting, and also to the direction of the grain of the metal. Pronounced effects of temperature have been noted and recorded. Investigations under the microscope with single crystals of metal subjected to the action of pressure, have shed light on the behavior of masses of the tiny particles in plates and rods, and the researches have also been extended to the case of fatigue in metals which are amorphous, where no crystallization takes place in the solid form.

Harvard Throttling Experiments Extend Data on Superheated Steam

By P. W. SWAIN*

THIS is the fourth and last article of a series[1] describing the steam-table research now going on under the auspices of the A.S.M.E. The first article showed why such an investigation was urgently needed and outlined the manner in which the work was planned and divided up among three great institutions. The second described the work being done on specific heat and heat of evaporation by Mr. Osborne and Dr. Stimson at the Bureau of Standards. That undertaken by Drs. Keyes, Taylor and Smith at M.I.T. was covered in the third article, which described the method there used for getting the relation of pressure, volume and temperature.

Each of these investigations, as has already been explained, was assigned to the institution and men best fitted by facilities and experience for the particular job.

The same considerations held in asking Prof. Harvey Davis and Dr. R. V. Kleinschmidt, of Harvard, to undertake the important task of determining the properties of steam in the superheated region by means of the Joule-Thomson effect.

The Joule-Thomson effect takes its name from the two English physicists who first called attention to the slight change in temperature that always accompanies the throttling of any vapor or imperfect gas. It is well known to operating engineers that the total temperature of steam passing through a reducing or throttling valve decreases, although the amount of superheat is ordinarily increased. The engineer also knows that in throttling there is no change in total heat, since no useful work is done. If the fluid throttled were a perfect gas, instead of a vapor like steam, no temperature change would occur. The temperature drop with steam is due to the fact that steam is not a perfect gas. That is to say, its molecules are so close together that the space taken up by the molecules, and their mutual attraction one for another, have an important effect. When steam expands, the molecules move farther apart. In this operation, which must take place against their mutual attractions, they are naturally slowed down with a resulting reduction in temperature. This is not the whole story, but gives some picture of what is taking place.

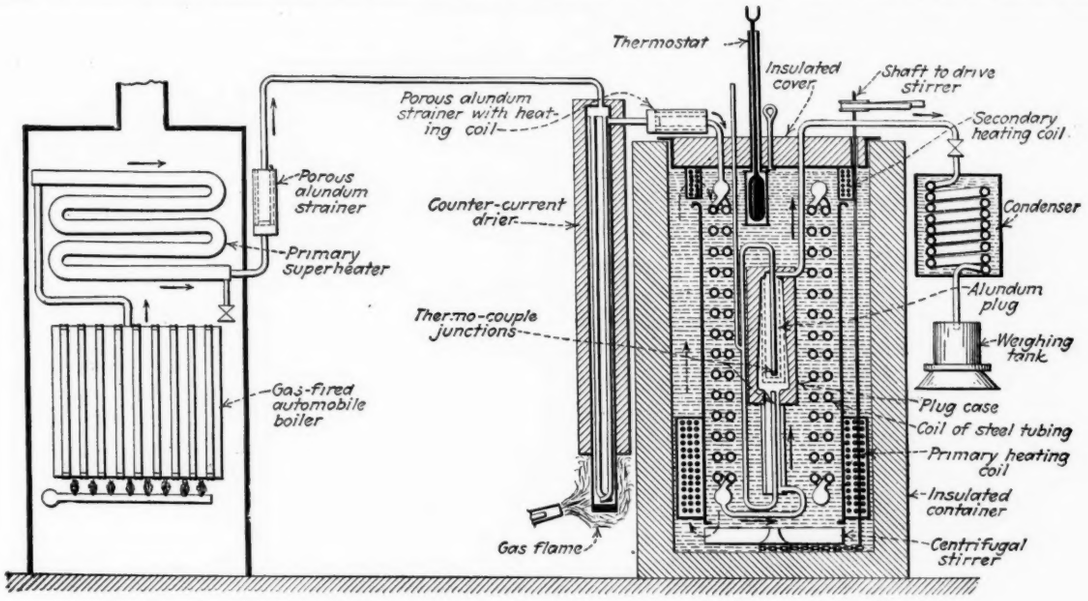


Fig. 1—Diagrammatic cross-section of apparatus, showing precautions taken to remove moisture from the steam

Practically, the exact theory of what is going on inside the steam is not important. The Joule-Thomson effect can, however, be used to the greatest advantage in getting steam-table data. Fundamentally, only four quantities need be measured, the initial temperature and pressure, the temperature drop and the pressure drop. Dividing the temperature drop by the pressure drop gives the Joule-Thomson coefficient, which is ordi-

PROFESSOR DAVIS and Doctor Kleinschmidt, using improved form of classical apparatus of Joule & Thomson, have already covered a range up to 565 lb. and 660 deg. F. The work may be extended to 1,200 lb. The method used consists in throttling steam through porous plugs and measuring temperature drop to 0.001 deg. F. Combined with Knoblauch's data on specific heat, this work will give highly accurate steam tables for superheated region.

*Assistant editor of *Power*.

[1]The other three articles appeared in the issues of Aug. 5, 12 and 17.

narily denoted by the Greek letter μ (pronounced "mu" as in music). The exact method of turning this coefficient into total heat and other steam-table quantities is somewhat mathematical and will not be described here.[2]

It should be noted that the coefficients measured represent only the amount by which steam deviates from a perfect gas. If this deviation is measured to a given percentage accuracy, it is evident that the percentage accuracy of the final result must be considerably higher. It is thus seen that Joule-Thomson measurements are ideally suited for the determination of the properties of steam.

It might be thought from this discussion that the apparatus for these measurements would consist only of a boiler, superheater and a throttling valve equipped with a pressure gage on the high side and mercury thermometers on both sides. As a matter of fact such an apparatus would be altogether too crude for the accuracy desired in the present work. The least trace of entrained moisture will throw off the results entirely. Therefore, extraordinary precautions must be taken to remove the moisture that is likely to be present, even in highly superheated steam, in the form of fine particles.

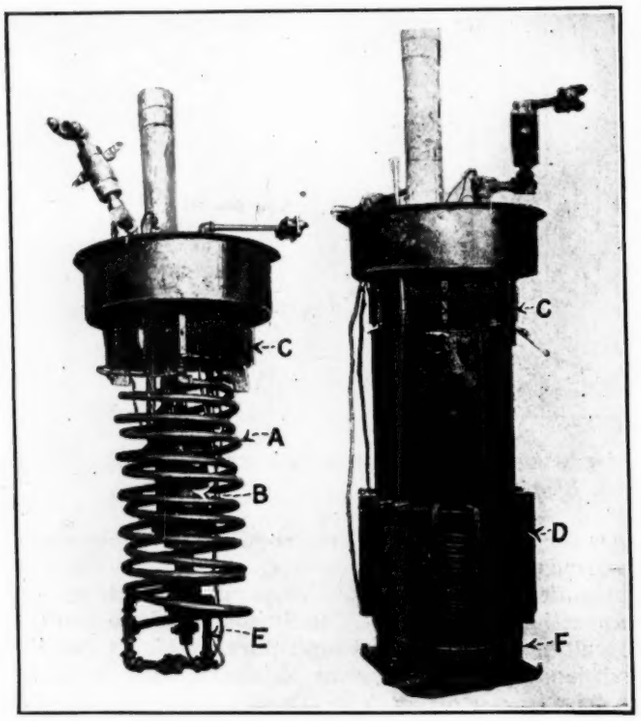


Fig. 2—The heart of the apparatus

Left: *A*—Steel coil to bring steam to bath temperature; *B*, plug case; *C*, small heating coil for final adjustment of bath temperatures, *E*—point where steam enters plug case.

Right: Same as left with outer shell in position. The stirrer *F* circulates the oil down through the shell, up through the main heating coil *D*, then through the final control coil *C*, after which it passes down around the steam coil and the plug case.

Again, the average temperature drop measured is around 2 deg. F. An error of one degree would throw off the results by 50 per cent. This, however, is not a difficult problem for physicists who can, by means of thermocouple with junctions at the two points, measure small temperature drops to an accuracy of 0.0001 deg. F. This is closer than necessary for the investigation.

A real difficulty is the leakage of heat into the lower temperature steam leaving the throttling apparatus. Every precaution is taken to avoid this. The throttling apparatus is immersed in an oil bath at the temperature of the inlet steam, and other precautions—to be mentioned later—are taken to avoid heat leaks. When

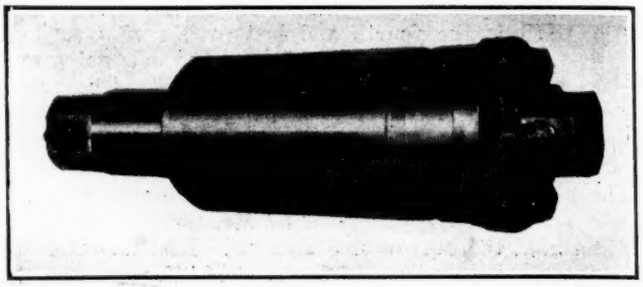


Fig. 3—View of plug case

everything possible has been done, there is still an appreciable leak, but this can be closely estimated and allowed for.

Another source of trouble is found in the general drift of temperature of the oil bath. A drift as small as one degree per hour would throw the Joule-Thomson coefficient off by at least 100 per cent. The method used is so refined that the drift is normally kept under 0.01 deg. per hour. This amount of drift causes a variation of about one per cent, most of which can be allowed for.

The throttling apparatus itself is not a valve, but a porous plug of alundum, which eliminates the velocities and other disturbing effects that would be encountered with an ordinary throttling valve.

So much for the general theory of the apparatus. The arrangement of the actual apparatus is shown diagrammatically in Fig. 1.

Steam Is Generated in a Small Gas-Fired Automobile Boiler

The steam pressure is kept constant by means of an electrical contact on the steam gage, which controls the gas fire through a relay. Another automatic regulator maintains the water level in the boiler. The wet saturated steam leaving the boiler passes through a primary superheater, which gives the steam a degree of superheat approximating that desired, and at the same time removes most of the water.

Passing next through a porous alundum strainer for the further removal of water, the steam passes down and up again through a counter-current drier so constructed that the downflowing steam is jacketed by that flowing up. An open gas flame playing on the bottom of this drier heats it to a temperature far above that at which measurements are to be made. This insures the evaporation of all drops of moisture. In passing up through the drier, it is again cooled nearly to the temperature of the steam entering the drier.

Any moisture that succeeds in running the gauntlet of primary superheater, strainer and counter-current drier is removed by another porous alundum strainer, around which is wound an electric heating coil. This is very closely controlled to bring the steam temperature almost exactly to the point required at the entrance to the throttling plug. Even with all these precautions

[2]For a scientific discussion of the Joule-Thomson effect see article by Dr. Davis in the May, 1915, *Physical Review*.

the steam is not yet considered to be in a suitable condition to enter the heart of the apparatus—the throttling plug case.

This plug case, as will be seen from Fig. 1, is submerged in an oil bath contained in a heavily lagged cylindrical tank 42 in. deep and 20 in. in diameter. The oil is maintained at the desired steam temperature, the oil used having the highest obtainable flash point. When the work is extended to the higher temperature ranges, it may be necessary to replace the oil by a mixture of sodium and potassium nitrates, as is done in the M.I.T. experiments.

A cylindrical shield about 15 in. in diameter and extending nearly the full height of the tank, divides the interior into an inner cylinder containing the plug

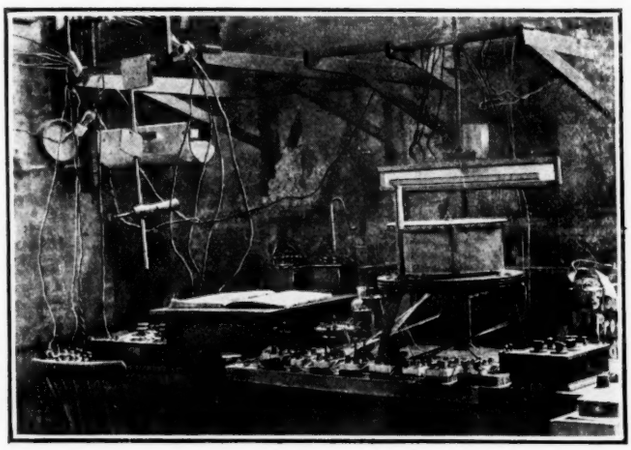


Fig. 4—Table for measuring and control instruments

case, and a surrounding annular space containing the primary electric heating coil for the oil. A centrifugal stirrer at the bottom of the inner shell sucks the oil down through it and forces it up around the outside through the heating coil. The current in this primary coil is adjusted so that it heats the oil nearly to the desired temperature, the remaining heating being done by a small secondary coil at the top of the annular space. A thermostat control on this coil maintains the oil temperature constant within 0.01 of a degree, or closer.

Before entering the plug case the steam, already extremely close to its desired final condition, is passed to the bottom of the inner cylinder through a coil of eight ½-in. seamless steel tubes, each 20 ft. long. As a result, when the steam reaches the bottom of the plug case its temperature is so close to that of the oil bath that no difference can be detected by a delicate thermocouple.

After this long process of preparation, involving every conceivable precaution, the steam enters the plug case in which the measurements are taken. The plug itself, which is shown by dotted lines, is an alundum tube 1 in. in diameter and 8 in. long, with walls ⅛ in. thick. It is closed at one end and supported by the plug case at the other. Steam passing through this plug from the outside to the inside, experiences a drop in pressure and temperature, both of which must be measured with great accuracy. The pressure drop is measured by means of a differential mercury gage and the temperature drop by a thermocouple, the two junctions of which are located close together but on the outside and inside respectively of the alundum plug. As has already been stated, such a thermocouple can measure temperature differences to 0.0001 deg. F. and with a probable error not exceeding 0.001 deg. As this is quite close enough for this work, the real difficulty has been in reducing and allowing for the leakage of heat.

It will be remembered that the Joule-Thomson coefficient has been defined as the temperature drop divided by the pressure drop when steam is throttled under conditions where there is no loss or gain of heat. An extremely small leakage of heat from the oil bath to the steam on the low-temperature side of the plug would throw the results off entirely. This objection to the leakage of heat does not apply to any heat that may leak through from the high-pressure steam itself, as such leakage merely amounts to taking money out of one pocket and putting it in another. Hence, to reduce the harmful heat leak, it is essential that the plug be jacketed with the higher-pressure steam to a point well back of that where the temperatures and pressures are measured.

This problem is satisfactorily solved by surrounding the plug with a 2-in. layer of asbestos wool through which a layer of jacket steam seeps on its way to the open end of the plug. With all these precautions there is still a heat leak that must be considered. An ingenious method has been developed for determining the amount of this leak under various conditions so that reliable corrections may be made.

The throttled steam, after leaving the plug case, passes to a coil submerged in cold water, where it is condensed and passed on to a weighing tank. The Joule-Thomson coefficient itself does not depend upon the weight of steam flowing per hour, but a fairly close measurement of the flow is needed in order to make the heat-leak correction.

Before taking actual observations to get the Joule-Thomson coefficient for a given temperature and pressure, it is necessary to let the apparatus operate under steady conditions for from one to four hours. Readings are then taken as rapidly as possible over two periods of a half-hour each. These periods are separated by at least an hour. If these two sets agree closely, the run is considered satisfactory and the flow is changed, keeping the high-side pressure and temperature the same as before. In this manner at least four runs are taken at different flows, with the same high-side pressure and temperature.

These four runs should all give the same Joule-Thomson coefficient, but they will not, unless correction is made for the heat leak. The effect of the heat leak is evidently most important when the smallest amount of steam is flowing. For the imaginary condition of infinite flow the heat leak would have no effect whatever, and the true Joule-Thomson coefficient could be taken directly from the measurements without correction. By plotting the actual coefficient against the flow in a specially devised manner, it is possible to determine with considerable accuracy what this correct coefficient would be.

It must be remembered that these four runs, involving perhaps two or three days' work, give only one point; that is, they give the coefficient for one combination of pressure and temperature. It is obviously impracticable to cover every steam-table entry by a separate experiment. All that is necessary in any work of this kind is to cover the whole range with a series of well-spaced points. Curves or equations developed to

fit these points will give the intermediate values to a high degree of accuracy.

In taking this job the Harvard experimenters were fortunate in having at hand a piece of apparatus already largely perfected. Since 1913 Dr. Davis, with the assistance of Dr. H. M. Trueblood and other scientists, has been working on practically this same investigation. Four years of work were required to get the first point. Repeated changes and improvements were made, so that the present apparatus is the result of a long evolution, and no serious difficulties may be expected in its use.

With this head start Drs. Davis and Kleinschmidt have already nearly completed the original program and will soon extend the work so far as possible, probably up to 1,200 lb. With this in view a small gas-fired Winslow[3] boiler, good for 1,500 to 2,000 lb. pressure, has been installed.

With the apparatus running day after day from 9 a.m. to midnight, this work involves much tedious routine. "Bug chasing" is an important part of the job. Fortunately, the nature of the work is such that improper results can immediately be detected and thrown out.

It has already been stated several times in these articles that the three investigations going on at Harvard, the Bureau of Standards and the Massachusetts Institute of Technology must all check with one another and with the work of Knoblauch. But suppose they don't happen to check, what then? It is evident that failure of any two of the investigations to check within the errors of observation would show one piece of work or the other to be defective. If no two checked the situation would be hopeless. The answer to all this is that such a situation will not arise. The investigators are not working in the dark with the idea of coming out after two or three years to see what results the other fellows have been getting. On the contrary they are keeping in close touch with one another. As soon as one accurately determines a certain point on his curves, the others will be informed of it and will immediately proceed to check it against their own work. If there is a discrepancy, all concerned will search for the trouble.

It is too early to say when the work at the three institutions will be completed and the results combined in a standard steam table. Research work, like invention, always involves unexpected difficulties and time-consuming side investigations. However, with much of the work at Harvard already completed and with the apparatus at the Bureau of Standards and M.I.T. about ready for the final runs, it is reasonable to expect that revised steam tables of some sort will be in the hands of engineers within two years, although the completion of the entire program may take longer than that.

The difference between accurate data and that which we now have, may not amount to any large sum of money on a particular job, but a saving of even a fraction of one per cent on each large steam-engineering job will, in the course of a few years, reach an astounding total, in comparison with which the estimated $90,000 cost of this research program will sink into insignificance. Great credit is due to George A. Orrok for his vision and energy in pushing this work, to the scientists who are co-operating so efficiently in carrying it out, and to those public-spirited engineers and business men who are backing it with contributions.

[3]This boiler was provided through the courtesy of Mr. Brown, of the Steam Vehicles Corporation of America.

Oil-Burning Methods

By A. L. Wernert

No installation employing mechanical atomization can be successfully operated unless the oil is delivered at constant uniform pressure at each burner and an even temperature at each burner, together with a constant and uniform supply of air at each burner. By carrying the oil pressure, oil temperature and air supply constant at each individual burner, we reach a balance condition. Then, and only then, will each individual burner do the same amount of work.

Various questions on operating procedure have been asked by students at the Todd Free School. Among the most important were those given here together with the answers.

Question: What is the proper oil pressure to carry at the burners?

Answer: Find out from the manufacturer of your particular type of mechanical burner the proper pressure to carry on your system with their burner in order to get good atomization. Once this pressure is determined, maintain it constantly, regardless of load conditions.

Question: What is the proper temperature to which the oil should be heated in order to get good atomization?

Answer: The proper temperature is that temperature at the burners which will reduce the viscosity of the oil to 8 deg. on the Engler scale, or 280 seconds on the Saybolt scale. In the past, engineers have depended entirely too much on the gravity of an oil to determine the proper oil temperature. Gravity readings practically give the engineer no information about the oil except the weight. When an engineer determines the temperature at which to heat the fuel to obtain good atomization by means of the weight, he is only guessing at it. Oils of the same gravity but differing in viscosity, require different temperatures; the higher the viscosity the higher the temperature necessary to atomize it properly.

A short time ago I had occasion to test fuel oil from four different plants for their specifications. These four fuel oils had the same Baumé gravity, 13 deg. at 60 deg. F. Two of these oils burned without much trouble, the third gave a little trouble, while the fourth, when sprayed on a wood fire, put out the fire. This illustration is given to show why the gravity does not give the engineer any information about the fuel oil with regard to the proper atomizing temperature. In the past, engineers usually determined by experiment the proper temperature at which to heat fuel oil. When carrying too low a temperature on the fuel oil, it will not atomize properly, thus causing the burners to smoke heavily. No quantity of excess air will clear away the smoke from this cause, and the only remedy is to raise the temperature of the fuel. When atomization is poor, it will cause a carbon deposit when the oil comes in contact with the heating surface before complete combustion takes place. With high temperatures it is difficult to get the required amount of oil through the burners, as heat increases the volume of oil and consequently decreases the weight of the oil passing into the furnace. In other words, while keeping the oil pressure constant and gradually increasing the temperature, a point is reached where the greatest amount of oil by weight will flow into the furnace. This is called

the "critical point." Beyond this temperature continued heating of the oil increases its volume and actually results in decreasing the capacity of the burner. Excessive heating causes vibration of the burner, tends to break down the oil in the pipe line and causes carbonization at the burner tips.

Authorities on mechanical oil burning have come to the conclusion that all fuel oils have about the same characteristics and can be burned with the same vane opening, air pressure or draft and oil pressures, when heated to that temperature which will reduce the viscosity of the oil to 280 seconds Saybolt. This is a decided advantage, since a satisfactory method of operating, once determined for any given load, can thereafter be used, although different oil be burned. Heating the oil above this temperature in no way improves the efficiency of evaporation and results in a direct waste of heat. This fact has been established by different authorities, and is the one most generally disregarded in practice.

Burning Oil Efficiently

Question: How can I cut down fuel consumption?

Answer: Although the oil may be delivered at a constant pressure and be finely atomized, it cannot be burned economically and completely unless the spray is mixed with air in correct proportions. This mixture must enter the furnace to form a perfect gas. The air must be delivered through the vanes of the register and must not enter the furnace in any other way. The vanes of the register are adjustable so that it is possible to increase or decrease the velocity of the entering air.

If sufficient air is supplied, combustion is incomplete and carbon monoxide (CO) is formed. Since this reaction does not liberate as much heat as will the formation of carbon dioxide (CO_2) the furnace temperature is low. Black smoke, carbon deposits on the heating surfaces and vibration appear. Too much excess air results in lowering the evaporative efficiency of the boiler. If more air is supplied than the carbon in the fuel can absorb, the excess is held in suspension and is of no value, as it absorbs heat from the carbon that is being burned, detracting just that much from the heat that would be given off to the boiler. A sign of excess air is a clear stack or dense white smoke.

If the proper amount of air is supplied, complete combustion is obtained; that is, the highest percentage of carbon dioxide (CO_2) without any carbon monoxide (CO). The higher the percentage of CO_2 the higher the furnace temperature and the greater the number of heat units liberated. A light brownish gray haze at the top of the stack is a sign of good combustion.

Many an engineer has said that he has no oil losses, he has no ashpit loss, he loses none at the pumps, there is no smoke, so where else does the heat go except into the steam? He thinks he is getting maximum efficiency. When questioned about stack temperature and carbon dioxide (CO_2), he claims his stack temperature cannot be much different from that in any other plant, and furthermore, he has no stack thermometer to tell him what it really is. As for CO_2, what is that?

Oil can be burned very economically with a high efficiency, or it can be burned wastefully. There are some installations in which no engineer is able to get anything like economical results, because of faulty design of furnace and burning equipment. In many cases, however, the fault can be traced to operating conditions where the men operating the plant either do not know the correct method of carrying their fires or are unconcerned whether good results are being secured or not.

In economical boiler practice there are two kinds of efficiency, one known as combustion efficiency and the other as absorption efficiency. Combustion efficiency pertains to the proper burning of oil with the least amount of air to produce the greatest percentage of CO_2. To obtain such results, a flame of rich yellow color must fill the furnace without gaps or open spaces along the sides or underneath through which excess air may pass unconsumed. The stack thermometer is an indication of the absorption efficiency of the boiler, and temperature should be logged from day to day, all charges noted and the cause of fluctuations investigated by the man in charge. Naturally, the flue gas will rise with dirty tubes, and some engineers have the tubes blown every day, whether they need it or not. Another cause of increased stack temperature is excess air. As this excess air is cut down, the flue temperature will drop in the same ratio. This is something that all engineers do not realize, and it is suggested that they make the experiment to convince themselves of this fact.

Oiling Small Turbines

By H. D. Fisher

The writer's experience has been all in industrial plants and with comparatively small units up to 3,000 kw., so that the following remarks must be understood to apply to such conditions. There is little doubt of the advantages of systems in which part of the oil is continuously removed, purified and returned, particularly for larger units in continuous service for long runs. For the small unit with little oil capacity, and which is regularly shut down at least over week ends, it seems doubtful to the writer whether the saving in oil will pay fixed and operating charges on the system, let alone providing one more piece of apparatus to be watched by the busy engineer.

Once the oiling system is thoroughly cleaned out at the starting up of a new unit, practically the only thing that has to be attended to, besides maintaining the oil at the proper level by replacing the small amount lost by leakage, vaporization or atomization at the bearings, etc., is to keep out water and prevent emulsification. Occasionally, a water-inlet nipple to a bearing lining will crack or a cooling coil spring a leak, but practically all the water getting into the oiling system comes from the steam seals.

Sometimes the water guard packing on the outside of the seal becomes grooved or too high a seal pressure may be carried either from leaky inner packing or from carelessness, but whatever the cause, small drops of water are shot out, parallel and close to the shaft, into the bearing housing. Here they mix with the oil coming off the ends of the bearing lining and, passing through the pump and system, gradually emulsify, forming a thick yellow slime in the bottom of the oil reservoir. This will separate to a certain extent, so that not all the water getting into the system is emulsified. Perhaps the best way to gage the accumulation of water is to replace the drain plug with a bushing and a ¾-in. or 1-in. valve. Be sure to plug the outlet of the valve so that in the unlikely case that it jars open or some curious visitor should be tempted to see what would happen if it

were opened, the turbine will not be wrecked by loss of oil.

At suitable intervals, such as once a day or twice a week, as proves necessary, draw off a half pint or so from this valve and observe how much water is obtained along with the oil. If this is continually found in appreciable quantities, and is followed by emulsion, the seal pressure must be adjusted and water guards gone over to eliminate the leak.

A Thermometer Makes a Convenient Indicator

A very convenient indicator also is a thermometer set in the oil outlet passage from the middle bearing. If this rises above the average for running when it is known there is no appreciable water leakage (which may be 130 deg. to 160 deg. F. according to turbine-room temperature and other local conditions), it is a pretty sure sign of water in the oil. If the water leakage reaches the point that the oil level rises in the glass, or emulsion begins to show in the lower part, things are pretty bad and it is time to take prompt action by drawing off all the water and emulsion that can be reached, filling up with fresh oil as the other is drawn so as not to get the oil level more than an inch or so below the mark at any time. This will prevent damage until the machine can be shut down for investigation.

By watchfulness along these lines, which requires no more care and attention than an oil filter, if indeed as much, one filling of turbine oil will run two or three months and on occasion as much as six months. When the oiling system is refilled, about 80 per cent of the oil can be drawn off clear and in good condition so that it may be used in an engine circulating oiling system or filtered in a small batch filter and used for motor bearing or similar machinery. The actual loss of oil, or saving in oil bill if the filtering system lived up to its specifications in every way, would be so small that the probable return on the investment would hardly be attractive.

Some base-type machines, with oil coolers and auxiliary pumps contribute to the operating man's peace of mind, who likes to feel a cool bearing, but in actual operating results on oil consumption alone, they would not justify the additional expense. Sometimes the oil-reservoir location seems poorly chosen and it is exasperating to disconnect the governor to get at the oil pump and, even worse, to catch the keys in the governor shaft coupling in replacing it. With regard to running characteristics alone the design has a considerable factor of safety, for such machines normally operate with the oil leaving the bearings at about 140 deg. F. A 2,500-kw. unit ran for several months in an emergency with the temperature between 190 and 195 deg. without giving any trouble or damaging the bearing linings. No accurate account was kept of the turbine oil used, but it was not extremely large.

Highest Quality Oil Should Be Used

Much is said regarding turbine oil, and while only the highest quality oil of the proper consistency should be used, any one of several reputable companies can furnish an oil that will give perfect satisfaction. Trade designations vary among the different companies, but as a rule all furnish their light grade for these sizes of 3,600 r.p.m. machines and the same seems to work well at 1,800 r.p.m. Geared units require a heavy oil on the gears on account of high unit pressure between the gear teeth. Certain bearings which ordinarily run very hot, require an even heavier grade, the designation of which can be safely left to the manufacturer.

In replacing the oil in a turbine, the entire amount in the reservoir must be drawn off and then the slime which sticks to the sides and bottom, scraped down to the outlet and the whole chamber wiped clean. If much water has been formed, the return piping and bearing wells also should be drained. The deposit will seldom be formed in these unless the system has been allowed to get in very bad shape. This is fortunate, as they are often difficult of complete access without dismantling the unit.

In refilling a turbine, great care should be taken not to forget the bearing wells, and with some oils it is advisable to turn the machine over for a few hours and then remove and clean the pump strainers as they seem to become clogged with a sort of lint. The easiest way to clean strainers is to wash them off with kerosene and then burn off any remaining dirt with pieces of waste soaked in kerosene. Poor oil pressure is, with normal feed to bearings, a sign of clogged strainer, which latter should be cleaned at once.

Treatment of Leather Belting

Where a belt appears harsh and dry, it is an indication that the natural oil has been exhausted from it and needs replenishing. The belt should first be carefully cleaned of surface dirt. This can be usually accomplished by rubbing with a piece of burlap or other coarse cloth. Naphtha or kerosene may be used to wash the belt if necessary. In extreme cases it may be advisable to use some sort of scraper. A sharp-edged wooden block answers nicely. It is absolutely necessary to have a surface that can be recognized as leather on both sides of the belt, as it is useless to put dressing on a belt already covered with dressing, dirt or oil.

The best method of dressing a belt is to put a little on the pulley side and more on the outside of the belt, always remembering that too much dressing is worse than too little. Apply only what the belt readily absorbs. The pulley side should not be greasy when the application is completed.

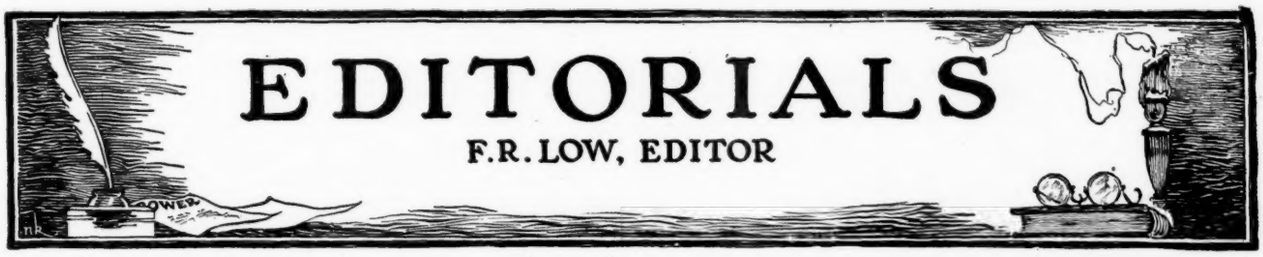
The best time to apply dressing is when the belt is idle and can stand for some time so that the dressing can penetrate into the leather.

Avoid surface dressings of all kinds, as they only collect dirt and cause the belt to slip. To remedy this slip more dressing must be applied and so on until the belt acts only as a carrier for a sticky gum.

The only excuse for the use of surface dressing is as first-aid treatment in an emergency, but it should be removed from the belt at the first opportunity.

Most users of belt dressing do more harm than good to their belting because they use too much dressing. Neatsfoot oil and castor oil make very good dressings, but the user invariably pours it on a belt from a can with little regard as to how much or how often he applies it, and in a short time his belt is so saturated with oil that it is like a rag and is materially weakened.

While the two oils mentioned make good dressings, they are not likely to be used successfully by the average mechanic and it is, therefore, best to use a commercial combination of greases, as it is less likely to be misused and is more economical. The idea of dressing a belt is to make it soft and pliable and not oily or sticky. —*From paper by Claude O. Streeter, Graton & Knight Manufacturing Company.*



Bottling Power in Chlorine

A SPEAKER at the recent meeting of the British Association for the Advancement of Science in Toronto is reported as predicting the future use of chlorine for transporting energy from waterfalls to distant industrial regions. The scheme is to generate electric power at the hydro sites and use this power on the spot to decompose common salt into its elements, sodium and chlorine. It is stated that the chlorine gas is to be transported to industrial centers for fuel.

On its face this proposal seems impracticable for a number of reasons. In the first place it is evident (assuming that the efficiency of the entire process of turning the electrical into chemical energy and later releasing chemical energy in the form of heat is equal to that of electrical transmission lines) that the operating cost of both the decomposing and combustion processes plus the entire cost of transporting and "burning" the chlorine gas must be less than the cost of electrical transmission for this method to be worth consideration. Whether there would be additional practical difficulties in producing the chlorine is for the chemist to say.

Even assuming these conditions to be met, the matter of "burning" the chlorine brings up additional difficulties. Oxygen or air could not be used to support its combustion. The chlorine might be made to unite with the sodium from which it had been separated or with hydrogen, which would have to be produced and supplied separately. The safe handling of an extremely poisonous gas, such as chlorine, would cause additional difficulties.

Finally, if the energy were required in any other form than simple heat, an additional power plant would have to be built at the consuming end. This would waste from seventy to eighty per cent of the energy received and pile up additional overhead costs. All in all, the possibility of this method of power transmission coming into general use, even in the distant future, seems rather remote.

Mouth-of-Mine Power Plants

THE idea of locating large power plants at the mouth of the mine and transporting electrical energy rather than hauling the raw coal has long held the public's attention. Engineers have been almost a unit in declaring that, owing to lack of condensing water, such a scheme was limited; to make the non-feasibility more apparent someone has pointed out that the Hell Gate plant in New York City uses for condensing purposes more water than is handled by the city's entire water system. But is the mouth-of-mine idea unattainable?

It must be considered that the amount of raw water required for condensing purposes is enormous, but there is no reason why a limited quantity should not be re-used. In fact the spray pond and cooling tower are by no means unknown to the power-plant engineer. The chief water loss is that due to evaporation during cooling, and this is not beyond the capacity of scores of coal-district streams. As a matter of fact many English central stations have found that it is more economical to locate the power plants many miles inland, near to the fuel and to consumption, and use cooling towers, than to take advantage of the seacoast's offer of ample condensing water. In any event the cost of pumping water in a cooling tower is less than freight rates on coal.

Still another phase is worthy of investigation. Steam turbines can be built to operate non-condensing with steam consumption well under twenty-two pounds per kilowatt-hour. Where freight rates are the larger part of the total cost of the coal delivered at tidewater or at an industrial center, then even the doubled coal consumption of such a non-condensing plant might be commercially more efficient than a condensing plant. On the basis of a doubled coal consumption the distance toward the industrial center that such mouth-of-mine power could be delivered would depend upon the ratio of mine coal prices to freight rates.

High steam pressures also offer means of reducing the steam used by non-condensing units. While going to a pressure of one thousand pounds gives some increase in the thermal efficiency of condensing units, the increase obtained with non-condensing units is still more marked. The idea of huge mouth-of-mine power plants should not be lightly dismissed without some intense study. It might assist in the solution of railroad congestion.

Where Efforts Are More Productive Than in Saving B.t.u.'s

GETTING good results from the power equipment involves enough work to satisfy many. There are instances, however, where the engineer may find it worth while to put some of his efforts in a slightly different direction with greater advantage to himself. In a time of slack production the pressure may let up to such an extent that some occasional activities are welcome even in addition to the maintenance and construction work for which this may be an unusual opportunity. On the other hand, a good job of operating may not receive due recognition, whereas a few improvements in other directions would impress the management at once.

Examples are frequently recorded where time, expense or material has been saved by personal application, and anyone wishing to look beyond the field of regular prescribed duties, need not lack for precedent. Increase of production is frequently an overwhelming consideration, of which those attached to power plants serving factories may take advantage. In other locations human comfort may be a special problem. The

developing and commercializing of improved apparatus is a well-known, time-worn and somewhat uncertain possibility. Many companies make special effort to encourage original suggestions.

It is obvious, however, that advances in various branches of engineering should be studied in this connection. As mentioned in a previous issue, recent developments in ventilating research make it possible to determine readily the result of temperature, humidity and air currents in terms of effective temperature, and the degree of relief made possible by a scientific adjustment of air conditions that are financially within reach can be easily calculated. High working temperatures, whether confined to the summer season, or due to other causes, offer a promising field, since the adjustment of air velocity or application of sprays does not ordinarily involve a prohibitive expense. Comfort in cold weather is an alternative in regard to which recent developments in heating systems should not be overlooked.

After all, obtaining suitable recognition is equal to, or, from the personal point of view, more important than, the goal of practical success. Therefore, in such undertakings the principal object should be to provide some means for definitely measuring or comparing the improvement obtained, in terms that are most readily understood and appreciated, as this is the lever by which such ends are usually best achieved.

Bleeder Heating in Isolated Plants

THE heating of feed water by steam bled from the main unit is now an accepted principle of central-station design. Hardly a new station of any size is constructed without provision being made for bleeding steam at from one to three points. It has been shown conclusively that, from the point of view of fuel consumption, it is best to heat the feed water in this way and drive the auxiliaries electrically with current produced by the main unit. In the interest of reliability certain concessions are made in most cases. These consist chiefly in the provision of steam or duplex drive for the so-called essential auxiliaries, the boiler-feed pump and the condensing-water circulating pump. Where the maximum of economy is desired, even these are electrically driven, with steam-driven units held in reserve for emergency use.

In spite of its almost universal use in the newer central stations steam bleeding for feed-water heating, and the use of electrically driven auxiliaries, is still a novelty in isolated plants. It would seem that there are many plants, particularly above 1,000 hp., where such a method of operation might be advantageous. In this connection an article by Linn Helander on "Heat Balance for Small Stations," in the recently published "Prime Movers Report on Power Station Heat Balance," is of interest. While this article is directed to a central-station audience, there seems to be no reason why the conclusions drawn should not apply to isolated plants of similar size operating under similar conditions. In fact, some isolated plants will be able to show a better load factor than the average central station, thus increasing the desirability of high economy.

The hypothetical station analyzed by Mr. Helander had a capacity of 5,000 kilowatts in two 2,500-kilowatt turbo-generators with 4,000-square-feet condensers. The station was assumed to heat the feed water by steam bled from one stage of the turbines. Auxiliaries were motor driven with reliability assured by dual drive in case of the condenser auxiliaries, and by a spare turbine-driven feed pump and draft fan. The steam pressure at the throttle was 230 pounds, the superheat 102 degrees and the vacuum 28½ inches of mercury. The bleeding pressure with single-stage heating ranged from 17.5 pounds absolute at full load to 10.6 pounds at half load. As compared with an otherwise similar station heating the steam by the exhaust of steam-driven auxiliaries, this plant figures a saving ranging from 1,200 B.t.u. per kilowatt-hour at full load to 1,800 B.t.u. at half load—in other words, a little over one-tenth of a pound of coal per kilowatt-hour. In the case considered this amounts to about four per cent reduction in the annual coal bill. The estimated increase in cost is almost negligible, but this, of course, must be worked out separately for any given installation before deciding finally upon this method of operation. These figures certainly show the advisability of giving careful consideration to the use of bleeder heating and electrically driven auxiliaries in the design of isolated plants of appreciable size.

These are strenuous times for consulting engineers and power-plant designers, working under pressure of the managements and spurred on by a spirit of professional rivalry to exceed past performances, in which every expedient and refinement is being invoked. However, one is sometimes led to question whether, in this strife to reduce the cost of a kilowatt-hour, the broader problem of heat utilization is not overlooked and opportunities for economy as well as fuel conservation passed up.

Engineers will view with regreat the passing of another historic firm, the Herreshoff Manufacturing Company, of Bristol, R. I., whose plant went out of existence last week. Although it will be remembered chiefly as a builder of fast yachts and small naval craft, its head, "Nat" Herreshoff, is one of the few remaining associates of George Corliss and has been responsible for many fine specimens of engine design.

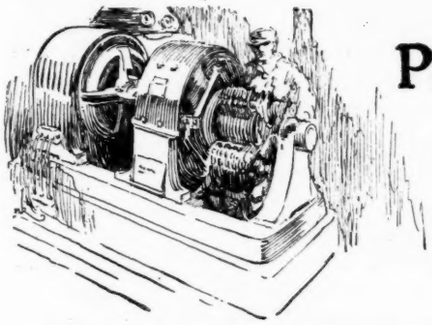
Coal production shows little improvement over last month. Whether through lack of money or indifference, the public has not heeded the advice to store and is apparently still unmindful of the fact that cold weather is not many weeks off.

An engineer who was accustomed to turning the hose on to the fuel bed once a day preparatory to cleaning the fire, could not understand why blisters should appear on the lower sheet of his boiler.

Lap-seam boiler explosion in Canada exacts toll of three lives. Too bad these menaces cannot be disposed of in some other way.

The British plan of designating the professional engineer has much to commend it over our practice of licensing.

The index for the first half of this year is available and will be mailed free to subscribers upon request.



Practical Ideas *from* Practical Men

Three Types of Back-Pressure Valves

Every heating system should be fitted with an automatic back pressure valve. A globe, angle or gate valve should not be used for this purpose, for the following reason: If the exhaust steam is not used as fast as the engine or turbine delivers it, an excessive pressure will be built up in the exhaust line. Many steam heating plants are fitted with radiators that are not supposed to carry more than 20 lb. pressure, hence if subjected to a higher pressure they may fail.

Where there is not enough exhaust steam to do the heating, live steam is admitted to make up the deficiency. This is controlled by an automatic reducing valve which is supposed to be in good order, but they are not always reliable, hence the automatic back-pressure valve acts as an efficient safety valve.

Fig. 1 illustrates a valve which requires only a small weight to hold it closed against any reasonable pressure. Steam entering in the direction of the arrow acts against the disk *A* tending to force it upward. At the same time it acts against the disk *B* tending to force it downward. If these two disks were of the same diameter, the valve would not open at all, but *A* is larger than *B* hence the the weight only acts against the difference in areas.

With this type of valve no means are provided for taking up the wear. However, when placed in vertical position, as shown, the valve is almost frictionless, hence the wear is very slight. A dashpot is located below the valve which makes it noiseless in operation. This is an important feature, especially in cases where not all of the exhaust steam is used. Sometimes the valve itself is made so that steam is trapped underneath it, and it acts as a dashpot.

Fig. 2 illustrates a valve that does not require a weight. A spiral spring acts on the short arm of a bell crank lever, which acts on the top of the valve as shown. Thus the valve is held to its seat by a spring, the tension of which can be regulated by the setscrew at the right-hand side. When a free exhaust is wanted, the setscrew at the left is screwed down, raising the valve from its seat, and holding it open.

Fig. 3 represents a valve which gives a greater opening than the pipe of corresponding size. In every case the length of the lever outside of the valve body does not represent the actual leverage brought to bear on the valve. Referring to Fig. 3, where the outside lever is hinged at *A* and the apparent leverage is from *A* to the center of the round weight *B*. This is partially offset by the inside lever, which extends from *A* to *C*, therefore the real effective leverage is from *C* to *B*.

This explains the necessity for having so large a weight on a valve of this kind, even when it is arranged to open at a light pressure. When a heavy weight is located near the ceiling of an engine room, it is a constant menace to all who pass that way, therefore, a small wire cable may be used by means of which the weight is located near the floor where it can do no harm if a setscrew should slip, or the lever break.

Although there are many different styles of back pressure valves these three valves represent typical types now in use, namely, those utilizing a small weight, the type using none at all, and those requiring a heavy weight. There is still another kind in which the weight is used directly on the valve stem, which projects

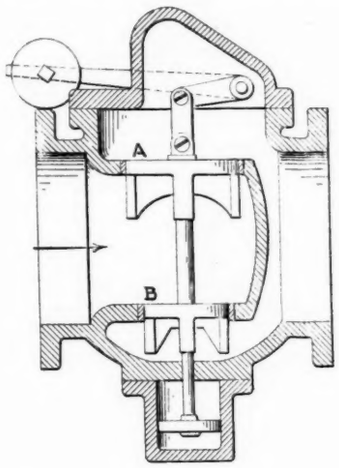


Fig. 1—Semi-balanced type of valve, requires light lever and weight

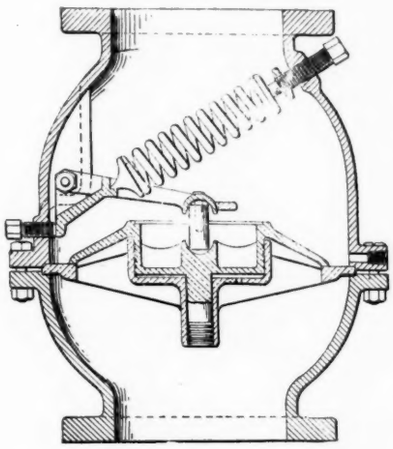


Fig. 2—Back pressure is regulated by tension of spring, no weights being used

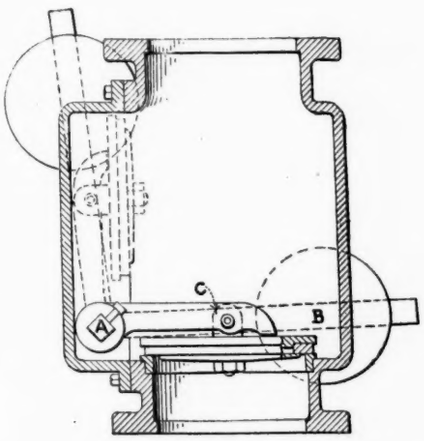


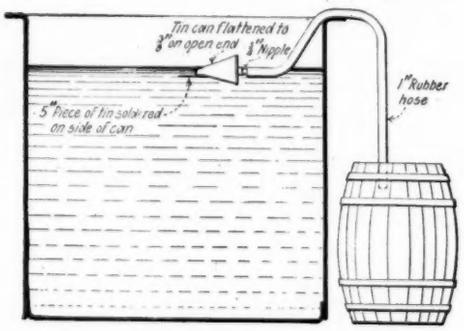
Fig. 3—Type of valve requiring comparatively heavy weight on lever

through the bonnet for this purpose, thus making a dead-weight valve, but they are only used for very light pressure, therefore they are not included here. Those presented are practical types, when used as illustrated, for use wherever it is desired to produce pressure in the exhaust pipe of an engine or a turbine.

New Haven, Conn. W. H. WAKEMAN.

Two Practical Kinks for the Power Plant

For skimming oil off the water in a hot well or open heater, take a good sized tin can and solder a coupling in the bottom, then flatten the top end almost together as illustrated, leaving about $\frac{3}{8}$ in. opening. Then on



Arrangement of oil skimming device

one side of the flattened end solder a piece of tin about 5 in. long and the same width as the flattened end. When using the skimmer keep the lip or piece of tin under the water just deep enough to keep two little whirlpools at the corners of the can. To start the skimming fill the hose with water by holding the end up as high as the top of the hot well. When the hose is full drop the can into the water and the end of the hose into a barrel or other vessel.

To make hydraulic packing last longer—take a piece of $\frac{3}{16}$-in. or $\frac{1}{4}$-in. diameter copper wire and shape it so that it will fit tightly around the rod and have a small space between the ends. Then tin the ends with the soldering iron. To put the ring on the rod bend the ends sideways the same as putting a ring in a chain. After the ring is in place solder the ends together and push the ring to the bottom of the stuffing box and follow up with the regular packing.

Colton, Calif. ROBT. A. DAVIDSON.

Why Should the Smaller Pump Give Better Results?

Recently, I tested out a centrifugal pump and the results do not quite follow my line of reasoning.

The pump is rated at 125 gal. per min. against a 139-ft. head, and this capacity, of course, is increased with a decrease in head. A 7½-hp. motor would drive the pump, but I had a 15-hp. motor installed so as to not overload it. A 300-gal.-per-min, fire engine was connected to a 4-in. main 2,000 ft. from the pumping station with the last 500 ft. of main falling 3 in. in 100 ft. and the first 1,500 ft. rising about 1 in. in 100 ft.

With the fire engine delivering one stream of water, the pressure at the pumping station was 50 lb. and at the engine 45 lb., with a nozzle pressure of 75 lb. A 1¼-in. nozzle was used, which resulted in a good fire stream.

Two lines of hose were then connected at the engine with 1⅛- and 1¼-in. nozzles. The nozzle pressure was maintained at 75 lb., but the suction pressure at the engine was reduced to 5 in. of mercury and the pressure at the pumping station reduced to 40 lb. This test resulted in two poor fire streams containing a large amount of air.

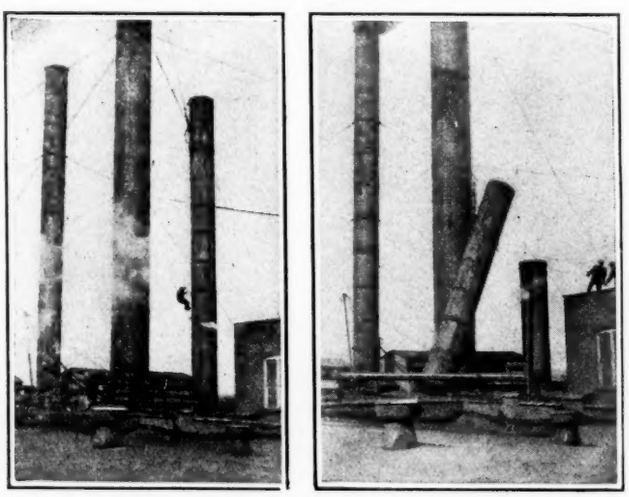
A 900-gal.-per-min. duplex pump was then put on the line at the pumping station and the centrifugal pump shut down. The pressure at the station was maintained at 60 lb. throughout the test through automatic control. The same pressure and equipment was maintained at the fire engine, showing a good solid stream when one nozzle was used, but a much poorer two-stream line than when the centrifugal pump was operating. Also the vacuum on the suction of the fire engine increased to nearly 7 in. of mercury.

I should appreciate it if some readers of *Power* would express their opinion as to reasons why the centrifugal pump rated at 125 gal. per min. with increased capacity under lower pressure showed better results than the 900-gal.-per-min. duplex pump maintaining the pressure constant. FREDERICK L. PAKES.

Stanton, Mich.

Replacing Smokestacks Without Interrupting Plant Operation

We were recently confronted with the problem of replacing our two steel stacks that were each serving a pair of water-tube boilers. Owing to the fact that the operation of the plant absolutely depended upon the use of a minimum of three boilers, it was out of the



New stack used as gin pole in removing old stacks and breechings

question to dismantle one of the stacks and replace it with a new one. Between the two settings there is a space of about ten feet which is used for the boiler-feed pumps, and we finally decided to put up a structure in this space to support a new stack capable of taking care of both pairs of boilers. After the stack was completely erected and new breechings were made up to fit in place of the old ones, we were able, by using the new stack as a pole, to take down the old breechings and one stack and install the new breechings. This was done over the week-end when the power plant was shut down. H. BRUNNER.

Trenton, N. J.

Comments from Readers

Electric-Boiler Explosion

I notice in the issue of July 22, 1924, an editorial about the explosion of an electric heating boiler. Regardless of the exact cause of the explosion, it is clear that the construction of the tank was not an entirely satisfactory one for any pressure vessel. No one who had appreciated the conditions would have used a flat head on a shell 2 ft. in diameter without bracing it, no matter what the method of joining the head to the shell.

In the welded construction the head joined to the shell with a corner weld is particularly objectionable and should never be used. Its weakness has been frequently pointed out and lies in the sharp corner at the intersection of the two pieces, which results eventually in a fatigue failure. The proper construction for all welded pressure vessels is a dished and flanged head joined to the shell with a butt weld. This construction has never failed.

It would be well for those having in use such boilers with flat heads, to realize the danger and to take the necessary precautions to avoid accident, which can doubtless be done by properly bracing the heads with through stays or in some other suitable way.

Long Island City, N. Y. S. W. MILLER.

Effective Gas and Air Mixing With Underfeed Stokers

Referring to the article of Mr. E. B. Ricketts in the May 13 issue relating to mixing gases on underfeed stokers, I should like to suggest means which I believe will lead to very high efficiencies.

From the article by Mr. Ricketts it might be believed that to obtain effective mixing in the boiler furnace the use of jets of secondary air or steam jets above the fuel bed on traveling grates—as shown in Figs. 1 and 2 of his article—is advocated.

Some manufacturers are using either air or steam jets above the fuel bed with underfeed stokers. But in my opinion this tends to decrease rather than increase the efficiency. Three fundamental conditions are necessary to obtain a perfect combustion: (1) The chemical condition, that is, the correct quantity of air; (2) the physical condition, that is, the highest temperature possible in the furnace; (3) the mechanical condition, that is, the perfect mixing of air and gases. The use of steam jets or air under pressure above the fuel bed which would seem at first rational to carry out the third condition is in reality a fallacy.

When air or steam is supplied to the furnace above the fuel bed, even when preheated or superheated, they are never at the same temperature as the gases, there being some 1,800 to 2,000 deg. difference. Consequently, this causes cooling of the furnace. Moreover, the steam or air under pressure when expanding in the furnace causes a further cooling and the physical condition for a good combustion is far from being attained. In addition to this the use of steam jets or air under pressure above the fuel bed cuts the travel of the flames reversing their direction towards the fuel bed. This causes the fusing of the ashes on the top of the fuel bed forming cakes which oppose the good distribution of air throughout. Also, it blows a great amount of burning particles of combustible and ashes against the heating surfaces of the boiler and in the flues, causing slagging which acts as an insulating material and reduces considerably the efficiency of the boiler.

Some twenty years ago I tried several types of steam and air jets above the fuel bed in an endeavor to reduce the smoke with hand firing, and I observed that in so doing I never increased the efficiency. This fact is plainly corroborated at the present time by the steam-jet stokers used in locomotives which have increased the coal consumption about 19 per cent in comparison to hand firing.

To obtain a good mixing of air and gases it is necessary to maintain a perfect porosity in every point of the fuel bed. Technically, the underfeed principle gives an easy way to perform the three conditions of a perfect combustion and by the combination of the driving of the fan and of the stoker, it is possible to supply a fairly good proportion of air and consequently to realize in a sufficiently satisfactory way the chemical condition.

Relative to the physical and mechanical conditions, an essential feature for their realization is the necessity of a perfectly porous fuel bed. By this I mean a fuel bed composed of small pieces of coke. These small pieces create a multitude of sinuous channels which air and gases are compelled to follow and which automatically insure a perfect mixing.

Moreover, when passing through this bed of burning fuel, air and gases take the same high temperature which brings their densities nearly equal and permit an easier mixing. This high temperature of the mixed gases automatically fulfills the second or physical condition. Practically, these two last conditions are not realized with a number of the existing underfeed stokers and the stratified flow of furnace gases pointed out by Mr. Ricketts often occurs.

Coal as generally used with automatic stokers is in small pieces and contains more or less moisture. With underfeed stokers, this coal is forced by means of a ram into a cylinder and then introduced into a retort under a thick fuel bed. On account of the necessary power to carry on this operation, the small particles of coal, which contain more or less moisture, are compressed and coal is forced into the retort in the shape of big compressed blocks which later form big lumps of compact coke.

At first, these lumps of coke form empty spaces between each other through which air rushes and holes in the fuel bed are formed. Moreover, compact coke is impervious to air, consequently air cannot mix with gases coming from the central portions of these lumps and the stratified flow occurs.

For these reasons the third or mechanical condition of a good combustion cannot be performed and in the

same way the second or physical condition cannot be realized.

In order to remedy these faults as pointed out in the foregoing, it is necessary to realize a perfectly porous fuel bed, that is, to produce a fuel bed exclusively composed of small pieces of porous coke. This in my opinion might be attained in the following manner: Instead of using in each retort one series of secondary pushers, use several series of stepped secondary pushers, the adjacent series reciprocating in opposite directions. This will produce a shearing action on the blocks of compressed coal as soon as they enter into the retort, and their compactness will be destroyed. Moreover, the continuous reciprocating movement of these series of stepped secondary pushers—to the full length of the retort—will give a constant wave-like motion in every direction to the entire fuel bed and tend to maintain a perfect porosity throughout the entire length of the retorts.

To perform the same effect in the extension grates or clinker pit, I suggest the use of grate bars reciprocating transversely to the movement of the fuel bed and in opposite directions for adjacent bars. This movement would tend to keep the fuel bed constantly leveled, giving a uniform thickness in every point and automatically preventing the formation of holes.

Moreover, due to the continuous shearing and shaking action of these movements of the bars the formation of the big lumps of clinker will be eliminated. This in turn will assist in preventing the clogging of the air inlets of these grate bars, as is the case with some stokers. These last grates compress the mass of refuse against the bridge wall and so force ashes and clinker through the air inlets which are rapidly clogged. The result of this clogging is a poor distribution of air and a high cost of maintenance due to these grates being uncooled and burning rapidly.

In addition to a good combustion, a great advantage accruing from the perfect porosity of the fuel bed will be the use of much smaller air pressures and probably the possibility to work with natural draft. This will give a saving of power needed by the fan, if not its suppression, and great reduction of the sweeping away of the fine particles of combustible with elimination of the slagging against the heating surfaces, a fault due to the high air pressures in general use. Another advantage is that on account of the good mixing the volume of the furnace might be considerably reduced, perfect mixing giving short flames. MAURICE RATEL.

New York City.

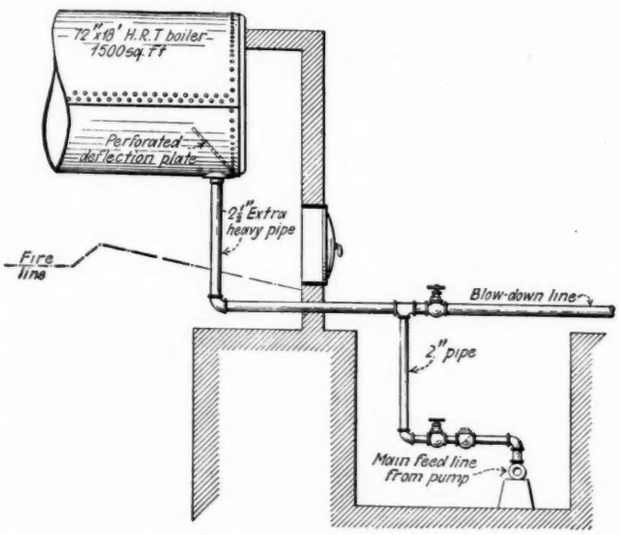
Where Should the Water Be Discharged in a Return-Tubular Boiler?

Referring to the article by R. McLaren, in the April 1 issue, on "Boiler Blowoff Pipe Failures," and also by Ira A. Butcher in the June 17 issue entitled, "Where Should the Water Be Discharged in a Return-Tubular Boiler," the accompanying illustration shows an arrangement of feed and blow-off line on four 18x72-in. return tubular boilers in our plant. This arrangement has in my opinion several advantages in its favor. It tends to keep a continuous circulation in the pipe which is important and obviates the necessity for covering or protecting the pipe as is the usual practice.

I am familiar with an installation operating at 125 lb. where the blow-off pipes are arranged similar to the one shown by Mr. McLaren in the April 1 issue. On one occasion when the engineer attempted to blow down the boiler he found the line plugged solid in the combustion chamber and the pipe red hot. Now I consider that a most dangerous situation and one that spells disaster if the stoppage in the pipe should break clear by being hammered from the outside by some inexperienced person.

With the feed line connected into the blow-off line you are assured at all times that the blow-off is clear. Some engineers entertain the idea that on equalizing pipe running from the top of the boiler to the blow down prevents deposits in the pipe but I do not favor that arrangement as the circulation is too slow and it invites neglect.

I have been operating our plant here with the feed line and blow-off pipes as shown in the illustration for twelve years with splendid results. Of course a good



Arrangement of feed pipe and blow-off-line on a battery of four return-tubular boilers

quality of extra-heavy pipe is used and the section of pipe that leads through the combustion chamber is renewed every two years.

I do object, however, to feeding cold water to the boilers during operation with this arrangement of feed piping as I am aware of the injurious effect it may have on the bottom plates and part of the tube sheet, but with water at 180 deg. or above it is, in my opinion, a practical way of feeding this type of boiler.

Aguathuna, Newfoundland. R. K. WALSH.

Why Is the Ice White?

I have read with interest the letter in *Power*, June 3, showing sketches of raw-water ice cans, wherein it is stated that one tank produces white ice. I have had an unusually broad experience with raw-water ice-making problems and am sure that I could assist Mr. Summers if I knew more about his conditions. Unfortunately, the article is not entirely clear and all the conditions are not known.

There are so many factors influencing the making of clear ice to be taken into consideration that a positive answer cannot be given. I would suggest that his principal trouble may be one of the following:

1. The air tubes are not of the same length in both cans.

2. He may not have proper restrictions governing the volume of air.
3. One tank may be farther away than the other.
4. The blower may be small.
5. Moisture may be in the line.

I notice that the author refers to restrictions, and he seems to think that because of the arrangement of the air valves cloudy ice may be the result. There is no doubt that if proper regulation and adjustments are made in both cases, it is immaterial how the valves are placed in the laterals. That is, it would make no difference whether one valve is used for each can or one valve for every two cans. The trouble, I should say, lies at other points. Again, it may be that he uses a poor quality of hose to connect his drop tubes to the galvanized ells on the extending arm to the can.

Among the troubles that I have encountered in raw-water ice making plants are such as these:

1. Too many perforations and holes in tubes.
2. Tubes are often too long.
3. There is an insufficient number of perforated holes.
4. Brackets are too weak.
5. Cans are not held perpendicularly in the tank.
6. Brackets are too clumsy.
7. Cans are not uniformly submerged.
8. Nozzles are imperfect or are not correct in size.
9. Orifices are not uniform.
10. Cheap hose which cracks easily, or spongy hose, which is liable to freeze and break.
11. The threads on couplings are not correct in size or are not carefully cut.
12. The manufacturers have not put enough corrugations on the nipples.
13. Tubes have slipped.
14. Soldering of sockets for receiving nozzles has been improperly done.
15. The tubes do not run down the center of the cans and consequently cause freezing on one side.

There are a great many more causes for white ice than these, but I am not certain whether even as much information as I have given here is wanted. I am certain that if one knew more about the installation one could quickly determine the trouble and if the installation could be seen it would be easy to locate the difficulty in a couple of minutes.

Philadelphia, Pa. JOS. A. MARTOCELLO,
Pres. Jos. A. Martocello & Co.

"It Pays To Do Your Best"

The contribution by Mr. Rye in the July 15 issue was read with interest, and, in my opinion, it presents a fine object lesson particularly to the young man just starting upon his career, as too many labor under the mistaken idea put forward by Mr. Rye, that their wages should be advanced by the simple process of personal application without thought of the *quid pro quo*. Many also, I fear, consider that because in their own estimation they are doing equal work with some other workman, they should by right draw the same wages. To the young man in such a position, I would say, "Have you ever studied the amount of time you are wasting in useless envy and jealousy against your neighbor?" This is, I think, one of the greatest fallacies pursued by the young men of today.

Many also start with the sole object of copying someone who has met with a due proportion of success, forgetting that to every one who succeeds in this task of envious imitation there are thousands of failures. The reason for this is simple, so simple, in fact, that many overlook it altogether. It is because "Smith" is "Smith" and "you" are "you," but Smith has discovered that in his composition is a combination of qualities that makes for originality, which marks him out from the rest, while you are wandering along like a lost sheep.

This was the position of Mr. Rye until he, so to speak, put himself under the microscope and made good, and I feel sure he prizes his improved position among men, who, like himself, have made good far more than any monetary advantage that has accrued.

There is in most of us a streak of originality, and it is the young men who search themselves until they discover it who reap the reward that the mere copyist can only dream about. Some years ago I had two sweepers under my charge, an elderly man and one much younger. The latter approached me for an increase of wages, his principal excuse was that he had to keep a wife and three children. I, of course, promptly turned him down, telling him to inform his wife that the reason for my action was that the old man could sweep the floors much better than he could. He left my office in doubt whether to cry or knock me out. Somehow I think he must have told his wife, for I soon noticed a great change, and it was not long before I concluded he was too good for his job and promotion followed, naturally with several increases of pay which he never asked for. Today he occupies a responsible position in the power plant of a large concern as chief electrician. All because he found a "better way of his own" to sweep floors which convinced me he would carry this "better way" with him before I gave him the charge of all the arc lamps about the place, which was the first step. The young man of today who will follow the example of this man, also Mr. Rye, and find the "better way" cannot fail because the mere fact that he has found it proves he is in the position to succeed.

The best aid for the young man in the power field that I know of, and I write from personal experience, is the mechanical press. It is many years ago that I commenced reading technical magazines to gain knowledge and to find out what others were doing and copy, if necessary, but preferably to use the ideas of others as a starting point to do better. Other young men around me looked upon this as a waste of money but they and not I found a rude awakening when a young man was required for a staff position. Since then my slogan has been read, read and keep on reading such journals as this and you cannot miss the "better way" of doing things. F. P. TERRY.

Belfast, Ireland.

That the maintenance charges on coal-pulverizing mills are considerably higher with anthracite than with bituminous coal is, of course, recognized. In an early attempt to pulverize river coal (coal dredged from the river beds in the anthracite mining region) with a unit pulverizer, the original set of paddles were completely worn away in an operating period of eight hours. Paddles of manganese steel were tried out and these increased the time between renewals to about sixty hours. The real cause of the excessive wear was, however, finally found to be due to the high percentage of sand in the coal. When this was removed, the life of the paddles was materially lengthened.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Coal Gas From Banked Fire

How can coal gas be prevented from filling the boiler room when fires are banked? *C. H.*

After the banking coal is placed, burn up the fire until a flame appears over at least a portion of the fresh fuel when the firedoors are opened. Then seal the ashpit doors with ashes and, with the firedoors nearly closed, adjust the stack damper to sufficient draft to prevent the gas from escaping through the firedoors.

Firing Return-Tubular Boiler Through Side Wall

What objections if any are there to having the fire and ashpit doors in the side wall of the setting of a horizontal return-tubular boiler? *R. N.*

The front end of the furnace would not be well supplied with air, although this objection could be overcome by providing a draft door or air inlet in the front wall. The leading objections would be weakening the construction of the side wall of the setting, loss of heat from the furnace and difficulty of firing that would result from reflection and radiation of heat from the opposite side wall.

Advantages of Multiple Valves for Pumps

Why are boiler-feed pumps supplied with a number of small valves in place of having one suction and one delivery valve? *W. G.*

Although a single valve has an area equal to the combined areas of four valves of one-half the diameter, to afford sufficient passage for the water the lift of a valve must be approximately one-half of the diameter of the passage. Hence a number of small valves of the same combined area as a single valve require less lift and can become seated more promptly, quietly and positively than a single valve; and when the required valve area is divided among several small valves, each one is easily and cheaply removed, repaired or replaced.

Relative Economy of Injector and Feed Pump

We have a small steam power plant with an exhaust feed-water heater, and for feeding the boiler we may use an injector or a steam pump. The injector cannot be set to operate continuously, and better economy seems to be obtained from operation of the steam pump. Is this not possible? *R. S. S.*

When no exhaust-steam feed-water heater is used, an injector, while it works, is more efficient than a feed pump, because all the heat of the steam used in the injector is returned to the boiler, excepting only that portion of the heat in the steam which is converted into energy for lifting the feed water and forcing it into the boiler. With a steam pump the same amount of heat converted into energy is used for handling the water, but some of the heat is lost in overcoming pump friction and none of the heat of the steam is returned to the boiler. However, if there is trouble in starting an injector or if it "kicks back" during considerable periods when it is supposed to be operating, the steam lost by blowing to waste may easily amount to more than that required for operating a small steam pump.

Bagging and Blistering

What is the difference between bagging and blistering of the shell of a boiler? *R. C. D.*

A bag is a bulging out and stretching of the sheet, usually occurring over the fire and due to plates becoming overheated from deposit of scale, oil or some material within the boiler that prevents the water of the boiler from keeping the sheet cool. Blisters are rough spots on the fire surface of the plates which usually are accompanied by "skin" cracks. Blisters occur in plates made up of several thicknesses, or may be due to quenching of the plates after rolling, or heating by the boilermaker, or have been known to occur from sudden cooling the boiler-heating surfaces by contact with cold air or water.

Sources of Loss from Cylinder Condensation

What are the causes of cylinder condensation tending to reduce steam-engine economy? *C. T. B.*

The sources of cylinder condensation are, mixing of the admission steam with steam of lower temperature in the clearance spaces, which always must be true when the admission steam is superheated or when compression is not carried as high as the initial pressure; alternate exposure of the cylinder walls to the admission steam and lower temperature of the exhaust, which however is partly prevented by compounding and employment of the unaflow principle of operation; and rediation of heat through the cylinder walls.

Cleaning Injector Tubes

How can the tubes of an injector be cleaned of scale without injury to the injector? *D. F.*

Remove the tubes from the body of the injector and cleanse them as well as possible by washing in a strong solution of potash and hot water and after rinsing in clean hot water, dip the parts in a solution of 1 part muriatic acid to 10 parts of water, leaving them submerged only long enough to soften the deposits. The tubes then should be quickly washed in clean cold water to stop the corrosive action of the acid. After the tubes have been cleaned, if they are polished they will remain free of scale for a longer period of use in the injector.

Bent Rocker on Single Valve Engine

In some single-valve engines why is the valve motion provided with a bent rocker? M. B.

From the irregularity commonly known as angularity of the connecting rod, the valve may have equal laps and port openings, but the piston positions at cutoffs will be unequal and equalization of cutoffs can be made only at the expense of unequal leads. By means of a bent rocker an irregularity may be introduced to equalize more nearly the cutoff and retain the equality of the leads.

Resistance to Flow of Steam by Elbows and Globe Valves

In computing the flow of steam through pipe lines, how is allowance made for the retarding effect of elbows and globe valves? D. L.

It is customary to allow for the resistance offered by fittings by assuming an added length of straight pipe that would have an equivalent resistance. There is considerable variation in the form and roughness of commercial fittings of the same nominal pipe sizes, and for the flow through fittings general rules cannot be established that are so closely in accord as the accepted formulas for flow through straight pipes.

However, for practical purposes, where L is the equivalent length of pipe in feet and d the diameter in inches, the length of pipe equivalent to the resistance of one standard 90-deg. elbow may be taken as found by the formula,

$$L = 6.3\,d \div \left(1 + \frac{3.6}{d}\right)$$

and for one globe valve,

$$L = 9.5\,d \div \left(1 + \frac{3.6}{d}\right)$$

Heating Surface of Return-Tubular Boiler

What would be the number of square feet of heating surface of a return-tubular boiler 66 in. in diameter by 14 ft. long containing 80 tubes 3½ in. in diameter by 14 ft. long? A. E. P.

For commercial purposes the heating surface of a return-tubular boiler usually is assumed to embrace the surface of two-thirds of the shell, the total surface of all tubes, based on their external diameter, and two-thirds of the gross surface of two heads minus twice the cross-sectional area of the tubes.

For greater convenience of computation, all measurements are taken in inches and the result found in square inches is divided by 144 for reduction to square feet of heating surface.

The heating surface of the shell = $66 \times 3.1416 \times \frac{2}{3} \times 14 \times 12$ =	23,223 sq.in.
Heating surface of tubes = $3.5 \times 3.1416 \times 14 \times 12 \times 80$ =	147,781 sq.in.
Two-thirds the gross area of two heads = $\frac{2}{3} \times 66 \times 66 \times 0.7854 \times 2$ = 4,561.6 sq.in.	
Twice the cross-sectional area of the tubes = $2 \times 3\frac{1}{2} \times 3\frac{1}{2} \times 0.7854 \times 80$ = 1,539.4	
Net heating surface allowed for heads = 4,561.6 — 1,539.4 =	3,022
Total,	174,026 sq.in.

which is equal to 174,026 ÷ 144 = 1,208.5 sq.ft. of heating surface.

After Condenser

What is an after condenser used in conjunction with steam power plants where there is a surface condenser? C. E. R.

The term after condenser is applied to the auxiliary surface condenser used for cooling the air and condensing the steam drawn from a surface condenser by a steam ejector, together with the live steam that is supplied for operation of the ejector.

Brine Circulation for Separate Refrigerating Rooms

For a 15-ton refrigeration plant consisting of an ice-making tank with a capacity of 5,000 lb. of can ice per 24 hours and refrigerator and cold storage rooms, to be cooled by circulation of brine, is it more desirable to have a loop system of brine piping in connection with the ice tank, or a separate supply and return main to refrigeration room? L. B. W.

Better control will be obtained with separate supply and return circulation for the refrigerating rooms supplied from a shell and tube brine cooler separate from the ice tank.

Evaporation of Water with Heat of Exhaust Steam

Under what conditions can evaporation of water be performed with exhaust steam? C. S.

Evaporation occurs from the free surface of water at any temperature when the space immediately above the water is not saturated with water vapor, and any increase of the temperature of the water, as by heat derived from exhaust steam, increases the rate of surface evaporation.

The more rapid production of vapor within the mass of the liquid, or boiling, takes place when the temperature of the liquid is raised as high as the temperature of saturated steam of the same pressure. For instance, steam at the pressure of 1 lb. gage or 15.7 lb. per sq.in. absolute has a temperature of about 215 deg. F. If sufficient heat is obtained from exhaust steam at this pressure to raise the temperature of water contained in an open tank to 212 deg. F., there would be rapid evaporation or boiling at or near the surface of the water, but evaporation within the body of the water would not take place at a depth where the pressure was 1 lb. gage, until the temperature at that depth has been raised to 215 deg. F., since that is the temperature of evaporation at 1 lb. gage pressure.

However, by reducing the pressure at the surface below the pressure of the atmosphere, and at the same time reducing the pressure of the liquid, as performed in vacuum pans and other forms of evaporators, a less temperature would be required to produce boiling or rapid evaporation. Hence, generally speaking, boiling or evaporation within a body of water can be accomplished with exhaust steam, provided the temperature of the water can be raised as high as the temperature which saturated steam has when at the pressure of the water to be evaporated, but that temperature of course cannot be made higher than the temperature of the exhaust itself.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications, and for the inquiries to receive attention.—Editor.]

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

Finding Actual Piston Velocity

AN ARTICLE in the previous issue showed that the velocity of a steam-engine piston varied from zero at the ends of the stroke to a maximum when the crank made an angle of 90 degrees with the connecting rod.

Nothing was said of the average velocity of the piston. This is always 63½ per cent of the crank velocity. To see that this must be so, it is only necessary to note that the crank travels around a circle while the piston travels a distance equal to twice the diameter of the same circle. That is, the piston travels 4 × crank radius while the crank travels 2 × crank radius × 3.1416.

Dividing the former by the latter gives

$$\frac{4 \times \textit{crank radius}}{2 \times \textit{crank radius} \times 3.1416} = \frac{2}{3.1416} =$$

0.635 = 63½ per cent.

When mention is made of the piston speed of an engine without reference to the position of the crank or the piston, the average speed is meant. Twice the stroke in feet multiplied by the revolutions per minute gives this piston speed in feet per minute.

Returning to the question of how the piston moves moment by moment, it was shown that while the piston speed was zero at the ends of the stroke, the acceleration, or rate at which the piston was being speeded up or slowed down, was greatest there. It is a little hard to picture how acceleration can be greatest when the piston is standing still. It may help to think of a trolley car being brought to rest by a sudden application of the brakes. The acceleration (negative in this case) is usually greatest when the car is practically at rest, as indicated by the violent effect on any passengers who may happen to be standing up.

On the other hand, the acceleration of the piston is zero when its velocity is a maximum; that is, when the crank reaches a point where it makes a 90-deg. angle with the connecting rod. Up to this point the piston is speeded up, rapidly at first and then more and more slowly. Before it starts to slow down again, there is a single instant when it is neither speeding up nor slowing down. At this instant the acceleration is zero.

All these statements hold regardless of the length of the connecting rod. The length of the rod does, however, have some effect on the size of the velocity and acceleration at different parts of the stroke. The previous article showed how to figure the velocities, etc., for an infinite connecting rod.

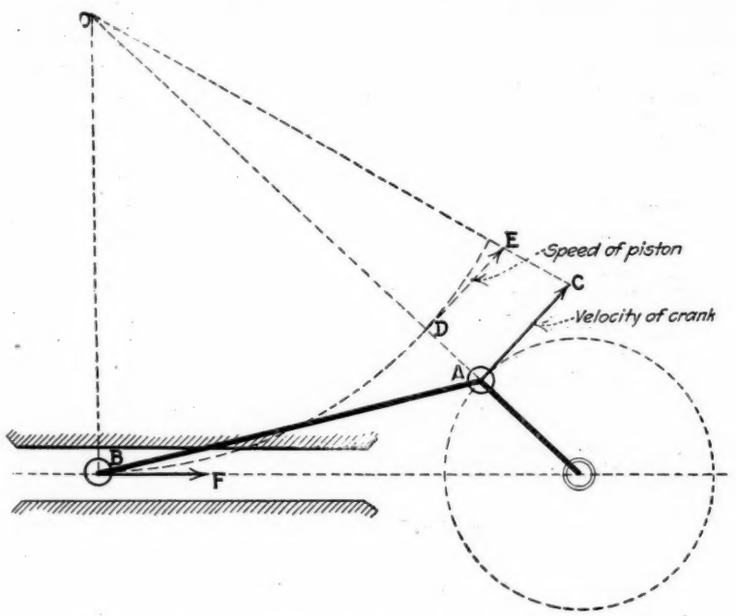
The case of an actual engine is a little more complicated, but even here it is relatively easy to figure the piston velocity for any position of the crank.

One method is shown in the figure. It is called the method of instantaneous centers and is based on the fact that at any instant all points in any moving solid body are rotating about the same point. All points in the connecting rod, for example, are rotating about some center which continually shifts its position. Each point in the rod must then be moving at right angles to a radius drawn from this center to the given point. The direction of motion is known for two points in the rod, the crankpin center and the wristpin center. The corresponding radii can then be drawn from these points at right angles to their direction of movement.

These two lines intersect at *O*, which must therefore be the center about which all points of the rod are rotating at the given instant. The crank and rod are laid out to scale in their proper positions and the crank velocity indicated by an arrow of the correct length (to any desired scale) and pointing in the proper direction. The radii *AO* and *BO* are drawn, their point of intersection being the instantaneous center *O*.

The next step is to find the velocity of the piston, which is evidently the same as that of the wristpin. When a body is rotating about any center, the velocities of the various points must be in proportion to their distances from the instantaneous center. So if *OB* is three-quarters *OA*, the piston velocity must be three-quarters the crank velocity. The actual ratio could be determined by scaling the two radii and dividing one by the other. The result, multiplied by the crank velocity, would give the piston velocity.

It is simpler to work this out graphically, using the principle of similar triangles. With *O* as a center swing an arc from *B* cutting *OA* at *D*. Then *OD* is equal to *OB*. Draw *OC* and run a perpendicular to *OA* out from *D* until it cuts *OC* at *E*. Then *DE* is the speed of the piston.



Finding piston velocity by method of instantaneous centers

This can be proved by the method of similar triangles. The right triangle *ODE* is similar to *OAC*, so all their corresponding sides must be in proportion. Hence *DE* is the same fraction of *AC* as *OD* is of *OA*. But *OD* is equal to *OB*, so *DE* is to *AC* as the distance of *B* from the instantaneous center is to the distance of *A*. The distance *DE* is then transferred to *BF*, which is the velocity of the piston.

The nearer the crank is taken to dead center the smaller will be *OB* in proportion to *OA* and hence the smaller *BF* in proportion to *AC*. When the crank is exactly on dead center, the point *O* falls on *B*. Being exactly at the instantaneous center, the velocity of the wristpin center (and hence of the piston) is momentarily zero.

Purifying Water for a Central Steam Heating Plant*

The makeup water for the central heating plant is 90 to 100 per cent raw water ordinarily, and this must be delivered high in purity in order to preclude possibilities of corrosion and to avoid contamination due to entrained salts when used in connection with industrial processes. The common undesirable constituents of raw water for central heating plants are: The carbonates and bicarbonates of lime and magnesia; sulphates, chlorides and nitrates of lime, magnesia and sodium; oxygen and carbon dioxide in the form of dissolved gases; industrial and domestic pollution, which are found in some surface waters.

Lime and soda ash have been in use for many years to prevent the formation of objectionable scale. The concentration at which the various compounds that find their way into the boiler and precipitate is variable and depends upon the ability of the individual compounds to remain in solution.

Foaming from Alkalinity

Carbonate of lime and hydrate of magnesia, for instance, precipitate at low concentrations, whereas hydrate of sodium, which usually is referred to as caustic alkalinity, remains in solution under conditions of extremely high concentration. Under such circumstances the result is to cause water to foam in the same manner as from the presence of soap. Blow-downs are resorted to in order to reduce this concentration. The effect of high caustic alkalinity in boiler water has been investigated and proved to cause embrittlement of steel.

Carbon dioxide gas may be free in solution or may be derived from bicarbonates of lime and magnesia in feed water. These are freed ordinarily in feed-water heaters and in live-steam purifiers, which therefore should be properly vented in order to become rid of the carbon dioxide. This gas has been found to be a minor factor in corrosion in comparison with oxygen. In the absence of oxygen the effect of carbon dioxide is negligible.

A boiler with four upper drums was the main feature of the central heating plant tested. The plant consisted of several such boilers. Raw water from the city was fed after chemical treatment in the feed-water heater, through live-steam purifiers. Return water (condensate) obtained from a portion of the heating system, entered the feed-water system with the raw water from the city mains.

On placing the boiler in service, it was found that the carbonate alkalinity of the boiler water remained fairly constant from the start, decreasing somewhat as the pressure and temperature increased until a minimum value was reached at the time the boiler went on the line. From then on changes were slight.

Bicarbonate alkalinity showed approximately the same characteristics, except that it disappeared completely when the boiler went on the line. Carbon dioxide gas was evident upon the appearance of the caustic alkalinity.

Caustic alkalinity is due to the excess amounts of sodium carbonate, necessarily added in treating, over that required to convert the scale-forming constituent of the raw water to a less harmful form. Insufficient bleeding of liberated gases in the purifier is the cause of the presence of calcium and magnesium in the boiler. The precipitation of the latter is not completed because of the recarbonization and solution of carbonates formed.

Carbon dioxide was found in the steam, which was in excess of the free gas entering the boiler. The excess is due to the decomposition of sodium carbonate in the boiler itself.

Since it is claimed that the formation of organic compounds is accompanied by the liberation of oxygen, and that no oxygen was found to be liberated in the boiler in excess of the amount of dissolved gas, it appeared that organic compounds were not formed.

The use of purifier steam in connection with main steam for heating purposes is liable to activate the steam for heating purposes so as to make it corrosive.

Purifiers were connected with the boiler drums for conditioning the boiler feed water. The purifier steam is that which had passed through the heating coils, and was tapped on to the main steam line and furnished to the turbine. When the turbine in the plant was shut down, purifier steam was not admitted to the heating system. About 500 lb. per hour is normally bled from each purifier, of which there are two on each boiler.

*Abstract of paper. "Some Aspects of the Boiler Feed Water Problem in Central Steam Heating Plants," By Max Hecht and C. H. Fellows, presented at the convention of the National District Heating Association, New York City, June 19-12, 1924.

Chartered Engineer

By E. J. Mehren
Vice-president, McGraw-Hill Co.

When I was in England in 1920 a project was under discussion for safeguarding engineering practice by restricting the use of the title "civil engineer." Its general object was similar to that of our licensing laws. It was hoped to establish by law qualifications and examinations for those who wished to use that title. Considerable difficulty was experienced, however, in pushing the bill, and the project was dropped.

Since then another solution has been found and is now effective. Under this plan the Institution of Civil Engineers and the Institution of Electrical Engineers have had reserved to their members, respectively, the titles, "chartered civil engineer" and "chartered electrical engineer." This was accomplished by securing changes in their charters, a procedure not requiring Parliamentary sanction, but falling directly under the King, acting through the Privy Council.

Under the new charter every member and associate member of the Institution of Electrical Engineers, during the term of his membership, may designate himself a "chartered electrical engineer," and no others may use the title. Prosecution will follow unauthorized use.

The effect is not restrictive of practice, as are our licensing laws. No one is stopped from practicing the profession of civil or electrical engineering, but no one, unless he be a member or an associate member of one of the Institutions may use the restricted title. The protection to the public must come from the effect of the prestige and efforts of the Institutions in convincing the public that civil or electrical engineering work is safely entrusted only to a "chartered engineer." Obviously, the word "chartered" in the title has a very considerable value in that it indicates a legal status of the title—this by contrast to the title "civil engineer" or "electrical engineer" which it was hoped to restrict under the earlier proposal.

Comparison with License

The advantages to the public, as against a licensing law, are obvious. There is no stamping, in the first application of the law, of a group of inferior practitioners with the same title as is given the most eminent men of the profession, while the legal requirements for entry to the profession are not so directly affected by public opinion. Under the English plan, the designated title can be made to represent what the ablest members of the profession consider the qualifications necessary to the competent performance of engineering work.

It does not, of course, protect the public against the quack. He may practice under the style "engineer" or even "civil engineer," but if the public will exercise reasonable intelligence it now has a means of assuring itself competent service.

The prestige of these institutions is, obviously, much increased. By inference, the government has constituted them arbiters of what is competence in civil and electrical engineering.

So much for the charter provision. In the by-laws of the Institution of Civil Engineers applying the charter provision, there is covered a supplemental matter that involves a point strongly debated in New York State—the licensing or recognition of corporations for the practice of engineering. The paragraph is worth quoting in full:

"A member or associate member practicing (1) under the title of, or as an officer or employee of, a limited company authorized to carry on the business of a civil engineer in all or any of its branches, or (2) in partnership with any person who is not a member or associate member of the Institution under the title of a firm, shall not use or permit to be used after the title of such company or firm the designation Chartered Civil Engineer or Chartered Civil Engineers, or describe or permit the description of such company or firm in any way as Chartered Civil Engineers."

The conclusion in England is the same as that reached in New York: a corporation may practice engineering but the restricted title in England, as is the license in New York, is reserved to the individual.

Present Situation of Electrical Undertakings in Japan*

By M. Shibusawa†

THE pioneer work of introducing electricity into Japan was done by the Tokio Electric Light Co. This company supplied electricity for lighting to a part of Tokio in 1887, with a few Edison dynamos each having a capacity of 10 kw. This undertaking was followed by many electric-light installations in other cities. In almost all of these undertakings steam power was used.

In May, 1891, the first hydraulic power plant in Japan was completed in Kioto, using water power from Lake Biwa. It supplied electric light and power to the city. The capacity of the station was 100 kw. at the beginning, but was extended up to about 1,500 kw. in the following years. In February, 1895, the first electric railway to be supplied from water power was started in this city.

In 1899 the first two long distance transmission lines were installed and began their operation with success, the cities supplied being Koriyama, the distance being 14 miles, power being supplied at 11,000 volts by a 350-kw. water turbine, and Hiroshima, energy being supplied at a distance of 14 miles by a 900-kw. hydro-electric set. The success of these plants brought about development of water power at various districts in the country. The principal lines are those of the Tokio Electric Light Co., which are 50 miles in length and served by the Komahashi 15,000-kw. hydro plant at 55,000 volts, and the Inawashiro Hydro-electric Co., which likewise serves Tokio, power coming at 115,000 volts from the 37,500-kw. hydraulic plant at Inawashiro, 141 miles away.

Unfortunately, the industrial districts of Tokio and Osaka are situated very far from the main water-power sites in the center of Japan. In the case of Osaka most of the power plants are steam driven owing to the cheapness and easy handling of coal. In spite of this the great success of the first high-tension long-distance transmission lines led to the proposal to lay transmission lines to Tokio, Nagoya and even Osaka. The transmission line system is divided roughly into two main groups: (1) From central Japan to Tokio, Yokohama and vicinity; (2) From central Japan to Nagoya and Osaka and vicinity.

Large transmission systems recently completed are as follows:

Power Company	Power Station	City Supplied	Mileage	Kilovolts	Kw.	Date Completed
Keihim Elec....	River Azusa.....	Yokohama	125	154	40,000	Feb. 1923
Tokio El. L. Co.	River Shinano.....	Tokio	125	154	40,000	Under construction
Daido Elec.....	River Kiso.....	Osaka	150	154	60,000	Dec. 1923
Nihon Elec....	River Masuda and Rivers in Toyama Pref.....	Osaka	200	154	30,000	Dec. 1923

When first introduced into Japan electricity was used for lighting only. The people in Japan are in general accustomed to have a house for each family, instead of living together in an apartment. This leads to the result that the number of lamps per house is very small. The rate of increase in the number of house connections is very great and still increasing, the increase being 12 per cent per annum. Moreover, as we have plenty of water power, distributed all over the country, electric lamps are so widely used that nearly 70 per cent of the houses are lighted by electricity. The industrial centers, Tokio, Nagoya, Osaka and N. Kyushu, use nearly 46 per cent of total lamps in the whole country.

As water power developed and consequently the cost of electricity was lowered, the application of electricity was gradually directed also to the use of electric motors. The horsepower of electric motors increased from 391,959 in 1914 to 1,552,332 in 1921.

At present the existing electric railways are limited to urban, suburban, local lines and very short lengths on the main lines. The electrification of the main lines has been under consideration for several years, and last year the Diet passed a bill providing for the electrification of the line between Tokio and Kobe, about 370 miles. The work on this section has been started. The earthquake disaster of Sept. 1, 1923, interrupted this work, but now the electrification is to proceed without delay. In 1912 there were 630 miles of lines and 3,420 electric cars, while in 1922 there were 1,296 miles and 6,715 cars.

The chief electrochemical industry is the manufacture of nitrogen fertilizers. The output of this material is increasing and, with abundant water power available, it is hoped that Japan will be able to produce all the fertilizer required for her own needs. In 1914 this industry used 24,500 kw. of installed capacity and 166,088 kw. capacity in 1921.

In agriculture at present about 20,000 kw. capacity is employed, mainly for irrigation and drainage. Power for agriculture is mainly required in the summer, which fortunately corresponds with the period when there is a surplus of water power due to the rainy season. It is hoped, therefore, to increase the supply of power for agricultural purposes.

The total installed capacity of power stations in Japan in 1912 was 204,596 kw. of hydraulic and 190,670 kw. of steam and gas power. In 1922 there were 1,008,139 kw. of hydro and 540,153 kw. of steam electric plants.

When water power took the place of steam power in 1906, the Tokio Electric Light Co., adopted a frequency of 50 cycles for its first transmission line. The machines were purchased from Europe, where 50 cycles was standardized. The same frequency was adopted by other power companies around Tokio.

On the other hand, power companies in Nagoya and Osaka obtained their machines from America where the standard frequency is 60 cycles.

Development of both systems went on independently.

About ten years ago, the Japanese Government made efforts to standardize the frequency. At that time, however, the necessity and advantages of interconnecting the two systems was not fully recognized. In addition, the change over of one of the systems would have been very expensive.

In consequence the efforts of the government were not successful in changing the frequency of either complete system, but the frequency was standardized within each system.

Recently, after the completion of the principal transmission lines from the water power center to Tokio and Osaka the necessity of the interconnection of both systems was keenly felt. The problem of the standardization of frequencies is again being discussed. But on account of enormous cost, we cannot yet come to a conclusion.

However, we are adopting a means of co-operation of power in both systems. This is done by constructing the new power stations at the water power center suitable to run at either frequency, 50 or 60, and these power stations can be run at either frequency depending upon the amount of power demand in both systems.

At present, there is one power station of 20,000 kw. capacity, designed to run at either frequency. This winter (1923-24) it was operated at 50 cycles and connected with the transmission lines to Tokio and helped the power shortage caused by the low water, while the corresponding power in Osaka was supplied by the reserve steam power plants. Thus, although the two systems are different in frequency, if there are sufficient number of such power stations, they can be worked as if they were interconnected.

In Kyushu and Hokkaido the power stations are also divided about half and half between 50 and 60 cycles. Therefore, we are planning to design the new power stations (water) to run at either frequency and thus to interconnect indirectly both systems.

On Sept. 1, 1923, Tokio and Yokohama were visited by the most appalling earthquake and fire in the history of Japan. Over a hundred thousand lives were lost, and the damage to property amounted to several billion yen. The damage to electrical installation was also very serious but fortunately very little damage was done to the water power stations which lie outside the earthquake zone.

As a result, within four months from Sept. 1 the supply of power had almost reached the pre-earthquake condition. As the ties are rebuilt, we may expect the supply of power to increase.

There is still a very large amount of water power that can be developed in Japan. In this we have the solution of the rapidly increasing demand of power and decreasing reserves of coal.

*Extract of paper read before the First World's Power Conference, London, Eng., July 1, 1924.

†President of the Institute of Electrical Engineers of Japan.

Industries Buying High Cost Mines for Own Use

Mines at Bargain Prices Are Being Bought by Public Utilities and Industries as Well as by Coal Operators

TWO DEVELOPMENTS of far-reaching importance are in progress in the coal industry. Consolidations have been effected and are in course of consummation almost sufficient to constitute evolution. The number of captive mines (mines operated by other than coal companies) is increasing by leaps and bounds.

When the Harding Coal Commission made its report, in which consolidations were recommended, there was no way of foreseeing that within a year an economic situation would develop that would bring about consolidations to an extent far beyond any hope the commissioners may have entertained at that time. Under the compelling pressure of slack demand and the prospect of a long period of uninterrupted production increasing numbers of high-cost mines had been forced upon the market. Since many of these transactions are kept as quiet as possible and because there is no centralized point at which figures covering such transfers are available, there is no accurate knowledge as to the extent to which this tendency has progressed. Those in the best position to judge express the belief that the more powerful companies have absorbed a larger number of high-cost mines than is generally supposed. If current rumor has foundation, several large deals of this character are about to go through.

Industry Stabilized

Before the end of the year, it is predicted, enough mines will have been acquired in this manner to give a new degree of stability to the entire bituminous industry. Normal requirements will be furnished by low-cost mines. The less efficient mines will be held in reserve to be called into production to supply peak periods of demand. In this connection authorities on coal point out that the bituminous industry in the past has taken little advantage of economies of large-scale production. The consolidations now being effected, they say, will do much toward setting an example in such matters as improved organization under ground—regarded as one of the weak spots in bituminous production. Better coordination or effort under ground as well as the employment of more engineers and better talent all call for capital expenditures which large interests can undertake and which are denied to those without such resources.

It is regarded as unthinkable that consolidations of bituminous mines could reach the point where any monopolistic control could be exercised. Even were a consolidation to take on a dominating character in a single district it would have to meet interdistrict competition. There has been serious discussion of large consolidation among the producers of smokeless coal. Even were it possible to effect such a grouping the industry could do no more than get into the anthracite class, but even then its product would be more vulnerable to inroads from substitutes.

While it is doubted that any unselfish reason could be advanced by coal operators to the captive mine this trend within the industry does not present the same constructive possibilities as flow from consolidations. These mines restrict the market more than they restrict the output. With the possible exception of the mines of Henry Ford these properties produce for their owners only.

Public Utilities Get Mines Cheap

Public utilities and the manufacturing interests are taking advantage of the existing situation, just as are the stronger coal companies, to buy mines at bargain prices. Here again the situation is clouded by uncertainty due to the fact that no central agency has the money with which to collect exact information. It is known, however, that the number of captive mines has increased greatly. The aggregate of their output is thought to be approaching two hundred million tons, more than one-third of the annual production. This tendency is thought to be having an appreciable effect on the price of coal.

Officials in Washington continue to emphasize their belief that the people of the Northwest have cause for concern for their supply of winter fuel. Unless there is an immediate improvement in the Lake movement the chances greatly favor a serious situation should there be an early descent of winter. The solution of the situation lies entirely in the hands of the consumers as coal must be moved off the docks before additional supplies can be received.

The City Council of Los Angeles has called an election for Aug. 26 to vote upon the sixteen-million-dollar issue of power bonds which the Bureau of Power and Light desires to float.

Large Diesel Power Plant Ordered

A 15,000 brake horsepower stationary Diesel engine of the two-stroke-cycle double-acting type has been ordered by the Hamburg (Germany) Electric Light Co. The work of building the engines will be jointly undertaken by Blohm & Voss, of Hamburg, and M.N.N., of Augsburg.

New Johannesburg Power Station Opposed

The Electricity Supply Commission of Johannesburg, South Africa, has proposed that instead of erecting its own new station, costing £525,000, the Johannesburg Council should take electricity from a superstation to be erected at Witbank. It is recommended that the Municipality take its base supply in bulk from the Witbank-Rand system, and use the existing municipal power station, augmented by the new 10,000-kw. set, to supply the peak load of the municipal demand. With this new set installed in the present station, Johannesburg will have 19,000 kw. of modern generating equipment to link with the Witbank-Rand system according to government reports.

Byllesby Buys Two New Properties

The H. M. Byllesby & Co. are announcing the purchase from the California Railway & Power Co. of the capital stock of the Sierra & San Francisco Power Co. of California. Announcement also has been made of the purchase of the St. Cloud Public Service Co. and subsidiary companies, operating electric light and power, gas and street-railway properties in St. Cloud and supplying electric light and power service to fifty-one other communities in central Minnesota, from the A. G. Whitney interests, of St. Cloud.

The Sierra & San Francisco Power Co. owns water-power plants of 60,000-hp. capacity on the Stanislaus River in Tuolumne County, 140 miles from San Francisco, a steam-turbine power house of 36,000-hp. capacity in San Francisco and a high-voltage transmission system of about 850 miles.

At present operated under lease by the Pacific Gas & Electric Co., the Sierra & San Francisco Power Co. system is already physically connected to two Byllesby properties, namely, the Western States Gas & Electric Co. near Stockton, and the Coast Valleys Gas & Electric Co. in the Salinas Valley. The company owns a number of valuable undeveloped water sites on the Stanislaus and Tuolumne Rivers.

Pumps Work After Being Under Water Seventeen Years

Pumps submerged seventeen years in the Baisley-Elkhorn mine, near Baker, Ore., were found in operating condition when the property was recently unwatered, according to Milnor Roberts, of the University of Washington. Water had stood in the four levels below the main adit since 1907.

When the mine was closed down, the pumps were well greased and left in good order. Unwatering was effected by means of a motor-driven turbine pump. When the water level reached a depth of 150 ft., air pressure was put on the pipe leading to the pump station on the third level, at a depth of 250 ft. Under a pressure of 95 lb. the pump responded at once and discharged through the 5-in. water column. While the pump was under water, it operated for about thirty hours, and after it had unwatered itself, it was continued in service for another twenty hours.

The water packing of the pump was in good condition, but the steam packing was soft and weak. The gaskets held but were spongy. The pump is a duplex steam pump altered to permit of the use of compressed air. It was made by the Stilwell-Bierce & Smith-Vaile Co., of Dayton, Ohio. Its size is 12x8x12 in. The mine water was not noticeably acid.

Cauvery River Dam Will Increase Power Output

The Cauvery River in India, rises in the Western Ghats, in the province of Coorg, traverses the Mysore Plateau for about 150 miles, after which it enters the Madras Presidency, eventually emptying into the Bay of Bengal. The construction of a storage reservoir across the Cauvery, known as Krishnaraja Sagar, was undertaken more than ten years ago, and it will not be finished for several years to come.

The dam, which is situated nine miles on the upstream side of the town of Seringapatam, is 124 ft. in height and permits of a storage of 44,827,000,000 cu.ft. of water. Of this quantity about one-fourth will be used for power generation, and the remainder for irrigation.

When completed, the reservoir will be the largest of its kind in India. The total length of the Krishnaraja Dam will be 8,600 ft. including the wasteweir and it will submerge about 50 square miles. At present the dam is 80 ft. high. The output of power generated at Sivasaniudram has been increased from 13,000 to 22,000 hp., while a further installation of 10,000 hp. is under consideration. The estimated cost of the dam, canals and connected works will be about 50,000,000 rubles, according to current press reports.

Ford Will Enter Retail Coal Business

W. B. Mayo, chief engineer, Ford Motor Co., when he arrived in Duluth on the "Benson Ford," with 12,000 tons of bituminous coal aboard, the first Ford boat to enter the harbor, announced that coal sales offices would be opened by the company in Duluth and the Twin Cities. At first, probably, only carload shipments will be sold. The cargo of the "Benson Ford" will go to the Ford plants in St. Paul and Minneapolis, but when, later, all arrangements are made, Ford-mined coal may be carried over a Ford railroad, the Detroit, Toledo & Ironton, be transported over the lakes in Ford boats, unloaded on a Ford dock (the Superior Coal & Dock Co.'s front just leased for one year by the Ford Motor Co.) and sold in Ford offices to the wholesale and retail trade, thus rescuing the Lake consumers from "the clutches of the coal profiteers." The D. T. & I., however, does not as yet tap Mr. Ford's eastern Kentucky fields.

G. H. Diman, Power Plant Pioneer, Dies

George H. Diman, one of the men who had a share in laying the foundation of the power industry in America and a man who was an inspiration to to men who carried on the industry, died on August 20 in his seventy-ninth year, at his home in Lawrence, Mass.

Mr. Diman was born in Fall River, Mass., Sept. 4, 1845. After receiving a public school education, he went to work on the railroad, where he labored alongside Henry Rogers, of the Standard Oil Co., when both were earning $1.25 a day. His mother made such objection to his becoming a locomotive engineer that he turned his attention to mill engineering. His first work in this line was at the Union Mill in Fall River.

At that time the modern steam power plant was not even the dream of the most visionary. The maximum steam pressure was from 80 to 90 lb., boilers were equipped with ball-and-lever safety valves and cast-iron piping with putty joints. No gaskets or glass water gages were used, and economizers and stokers were not even thought of. Most of the engines were of the Corliss type, and the largest engine in New England was less than 1,000 hp. There was not a single indicator in the city of Fall River and very few in New England. The question of coal saving was almost never given any consideration.

Mr. Diman early turned his attention to fuel economy, and throughout his connection with the power plant industry it continued to interest him. He was especially interested in improvement in the economy of fuel consumption in the boiler room.

While at Fall River Mr. Diman became acquainted with George H. Corliss. This acquaintance ripened into a close friendship which lasted up to Mr. Corliss' death. In 1875 a pair of Corliss engines totaling 1,200 hp., were installed in the Social Mill, Woonsocket, R. I., and Mr. Diman took charge of them for Mr. Corliss, whose

Third 70,000-Hp. Hydro-Electric Unit Started

Largest Power Plant Under One Roof in the World at Niagara Falls

ON SATURDAY, August 16, the Niagara Falls Power Co. started the third 70,000-hp. hydro-electric unit in its plant, known as extension No. 3-B. This unit, after being subjected to the usual tests, will go into regular service on the company's power system. The putting of this machine into service will give a total normal rated capacity of 452,000 hp. under one roof. If the overload capacity of the machines is considered, the plant is capable of supplying a load of over one-half million horsepower and this makes it the largest power plant, under one roof, in the world.

The turbines for the first two 70,000-hp. units to be put in service were built by the Wm. Cramp & Sons Ship & Engine Building Co. and the generator by the General Electric Co.; the third unit complete was built by the Allis-Chalmers Manufacturing Co.

This development consists of a 32-ft. concrete-lined tunnel nearly a mile long, three 21-ft. diameter penstocks and three 70,000-hp. units to operate under a normal head of 214 ft. Power is generated at 12,000 volts and is stepped up to 66,000 volts through three banks of transformers. These units use the water that was originally utilized in two of the company's older plants and will produce approximately double the power produced by the older machines from the same quantity. This is partly due to the high efficiency of the new units and partly to the higher head that the new machines operate under. The head on the old machines is about 140 ft. compared to 214 ft. for the 70,000-hp. machines.

Worthington Builds New Diesel

The Worthington Pump and Machinery Corp., New York City, has been engaged during the past three years in developing a double acting two-stroke-cycle Diesel engine. The engine, of 850 horsepower per cylinder, has shown such gratifying results that the builder has invited a number of representatives from engineering publications, and other interested parties, to visit the Buffalo plant for an inspection of the unit.

Old Armington-Simms Engine Goes to Museum

According to press reports the old Armington-Simms stationary engine used by Thomas A. Edison at Sunbury, Pa., to operate the dynamo of the world's first electric light plant was shipped to New York City on Aug. 21. It will be connected to the original dynamo which is now in the Museum of the Historical Electrical Collection, 43 Gold St., New York City. The dynamo was sent there two years ago.

The engine weighs five tons and has been lying in a pile of junk in a trolley barn. It was recovered by Harry L. Keefer, of the Sunbury High School.

contract required him to guarantee against all breakages for one year. It was about this time that he became interested in compound engines, as he noted that compounding was very common in England. The English engines were mostly equipped with slide valves and throttle governors, so they did not show exceptional economy, but Mr. Diman felt sure that Corliss engines could be made to show very good results if compounded. Objections were made to the idea, but when additions were made to the mill he induced Mr. Corliss to install the first compound engine put into a New England mill.

After seven years at the Rhode Island plant he took charge of ten obsolete mills in Massachusetts. By intelligent reforms in operation and management he reduced the operating costs and increased the efficiency of the plant. Later he became connected with the Washington mill in Lawrence, Mass., where he remained until his retirement from active duties a few years ago.

He was a member of the A.S.M.E., N.A.S.E. and was the only honorary member of the Engineers' Blue Room Club of Boston.

Grand Falls Project Better Than Expected

Conditions for hydro-electric development on the St. Johns River at Grand Falls, New Brunswick, Canada, are better than was anticipated when the project was launched, according to a report submitted governmental agencies in Washington by Frederick C. Johnson, American vice-consul at Fredericton. The gist of the report follows:

"Complete detail surveys of the possible storage reservoirs, dam sites, etc., are being made, and these surveys to date show that the preliminary estimates were conservative and that watershed conditions and storage possibilities are better than expected. Several months will be required to complete the survey before it will be proper to make formal application to the International Waterways Commission in order to secure permission to develop the site.

"Some of the works will affect, in a small measure, the foreshore of citizens of the State of Maine, and the permission of the International Waterways Commission is necessary before these structures can be erected.

"The development project is being carried forward under the authority of the New Brunswick Electric Power Commission. The initial plan is to develop 40,000 hp. on the Canadian side of the falls, but ultimately to develop 120,000 hp., provided satisfactory arrangements can be made for storage dam sites in the State of Maine.

"The initial work at Grand Falls will be laid out in such a way as to take care of the ultimate development, and in any case the maximum development that can be obtained from Canadian storage will be proceeded with."

Franklin Institute's Centenary Celebration

The Franklin Institute will hold the centenary celebration of its founding and the inauguration exercises of the Bartol Research Foundation on Sept. 17-19 at Philadelphia. In the long list of interesting subjects and famous speakers scheduled for this celebration the following papers and speakers are of particular interest to *Power* readers: "Some Aspects of High Pressure Research," by Prof. P. W. Bridgman, of Harvard University; "Mercury Boiler," by William LeRoy Emmet, of the General Electric Co.; "Stimulation of Research and Invention," by Prof. D. S. Jacobus, of New York City; "The Restraint of Exaggerated Grain Growth in Critically Strained Metals," by George L. Kelly, Philadelphia; "Paper," by Dean Dexter S. Kimball, Cornell University; "Electric Discharges in Gases at Low Pressures," by Irving Langmuir, General Electric Co.; "Steam Turbines on Land and Sea," by Sir Charles Algernon Parsons, Newcastle-on-Tyne, England; "A New Type of Non-Inductive High Resistance," by Dean Harold Pender, University of Pennsylvania; "The Field of Research in Industrial Institutions," by E. W. Rice, General Electric Co.; "The Natural and Artificial Disintegration of Elements," by Sir Ernest Rutherford, Cambridge University, England; "Early Science in Philadelphia," by Provost Emeritus Edgard F. Smith, University of Pennsylvania; "Paper," by Frank J. Sprague, of New York City; Speech by Prof. Elihu Thomson, General Electric Co., West Lynn. Attractive plans for luncheons, dinners and garden parties have been made by the committee.

Elihu Thomson is chairman of the honorary committee of the centenary celebration, which numbers among its members Thomas A. Edison, Charles A. Coffin, Samuel Insull, Joseph B. McCall, Nicholas F. Brady and other men prominent in utility and industrial circles. William C. L. Eglin is chairman of the executive committee.

Production of Bituminous Coal 1924-1918

In Thousand Net Tons

	1924	1923	1922	1921	1920	1919	1918
January	50,801	50,178	38,930	41,148	49,748	42,193	42,227
February	45,725	42,160	42,425	31,524	41,055	32,103	43,777
March	39,909	46,802	51,936	31,054	47,850	34,293	48,113
April	29,447	42,564	16,335	28,154	38,764	32,712	46,041
May	31,236	46,076	21,005	34,057	39,841	38,186	50,443
June	30,447	45,490	23,096	34,635	46,095	37,685	51,138
July	.....	45,126	17,602	31,047	45,988	43,425	54,971
August	.....	48,864	26,755	35,291	49,974	43,613	55,114
September	.....	46,216	42,463	35,870	50,241	48,209	51,183
October	.....	49,177	46,733	44,687	53,278	57,200	52,300
November	.....	42,911	46,900	36,805	52,576	19,006	43,895
December	.....	39,836	48,088	31,650	53,257	37,235	40,184
Total	.....	545,409	422,268	415,922	568,667	465,860	579,386

Source: United States Geological Survey.

Lignite Coals Will Be Developed

Co-ordinated research will develop the brown coals of the Empire into a product of first importance commercially, according to W. A. Bone, professor of chemical technology at the Imperial College of Science, who addressed chemists at the British Asssociation on Aug. 12. Brown and lignite coals, which take a prominent place in Professor Bone's classification of the sub-bituminous fuels, are found in extensive deposits in the various colonies and dominions, he indicated, in throwing out the suggestion that research by chemists and engineers will make it possible to utilize many of these reserves, which are at present receiving little attention.

"Progress has been made in disposing of the difficulties which are in the way of using these fuels on a wide scale," said Professor Bone in describing experiments which have been made to improve them by drying, heat-treating, and carbonizing.

Southern California Edison Rate Case Reopened

Less than a week after granting the Southern California Edison Co. an emergency rate increase of 10 per cent, the California Railroad Commission issued an order reopening the case and calling a hearing for Aug. 13 in Los Angeles. The 10 per cent increase applied to all schedules except agricultural rates, effective Sept. 1, for a period of eight months, and was granted to the company because of the abnormal expense to which it has been put in generating steam power and purchasing energy from other utilities to meet the shortage of hydro-electric power in Southern California.

The reopening of the case comes as the result of a dissenting opinion filed by Commissioners Clyde L. Seavey and Egerton Shore. They base their opinion on five points, namely:

The principle of basing rates upon average conditions over a period of years rather than upon special conditions of any particular year.

The unsoundness of granting emergency rates in the face of the company's present ability to pay 8 per cent dividends on its common stock.

The injustice of imposing upon the company's consumers, the cities, industries and other public utilities dependent upon this company for their electric light and power, of the extra burden of sharing the company's temporary losses in addition to the hardships and losses which they themselves are enduring from the same causes.

The incompleteness of the record in the proceeding, which did not include any report of check made by the Commission's engineers.

The failure of the majority decision to take into account the accumulated surplus of the company, which, according to the dissenting Commissioners' opinion, together with the contingency reserve and the estimated net revenue for the year, enable the company to meet all operating expenses, depreciation annuity, interest on bonds and

all dividends on stock, including 8 per cent on its common stock, and still leave a modest surplus.

The dissenting commissioners held that if any conservation is required it should be made by reduction of the common stock dividend rather than by any temporary increase of rates.

The company claimed that because of the existing abnormal power costs it would suffer a loss of about $5,600,000 in its net revenue under present rates and asked the commission for an increase in rates to produce additional revenue amounting to $3,000,000. The commission, however, did not allow this claim in granting the 10 per cent increase but made an order cutting the company's demand to an increase estimated to yield revenues of approximately $1,100,000.

Owens River Gorge Still in Dispute

The Southern Sierras Power Co. has filed an amended application for a license covering the project in Owens River Gorge for which the City of Los Angeles also is claiming rights.

The lands involved in this power site have been the subject of legislative action. In 1906 Congress authorized the sale to Los Angeles of certain of these lands in connection with its aqueduct project. On this authority the city bought up large areas in the river valley. Some contend that these purchases exceeded any area contemplated by the act of Congress. The General Land Office at one time questioned the validity of the transaction, but the Secretary of the Interior confirmed the sale of these lands to the City. A patent finally was issued in 1913 but it contained certain reservations as to the outstanding water rights.

An act approved June 5, 1920, extended the scope of the original grant but contained a number of conditions which invite controversy.

The Southern Sierras Co. contends that these reservations and conditions were inserted in the law to protect its established rights and those of its predecessors in this section of the Owens River.

On this assumption the Southern Sierras Co. applied for the license, which is in direct conflict with the Los Angeles program.

Report Out on Wisconsin's Installed Water Power

The Wisconsin Railroad Commission has just published a 575-page report containing complete data on dams and hydro-electric plants in that state. Of the 609 dams in the state 100 are used exclusively as power dams for public service purposes, 335 as power dams for private purposes, and 23 are used jointly as power dams for private and public service purposes. In addition, there are 115 dams not used for power purposes. The private power dams are used mostly for milling purposes, particularly by the paper industries. The investment in hydro-electric plants in Wisconsin is estimated to be in excess of $60,000,000.

The Wisconsin River develops the largest amount of water power; the Chippewa River, in conjunction with the Flambeau, the second largest, and the others follow in this order: St. Croix, Menominee, Peshtigo, Oconto, Red Cedar, Apple and lower Fox.

The largest hydro-electric development is at Wissota. It is owned by the Northern States Power Co. and has an installed capacity of 50,000 hp. The Kilbourn and Prairie du Sac dams, owned by the Wisconsin River Power Co. are the second largest. Other large water powers are at St. Croix Falls, Wausau, Big Falls, Jim Falls, High Falls and Johnson Falls.

The report goes into great detail as to the location of rivers, drainage areas, water-discharge measurements, channels and control, and other hydrometric data.

A.I.E.E. Program for Pasadena Meeting

The American Institute of Electrical Engineers has announced a tentative list of technical papers to be given at the coming convention which is to be held at Pasadena, Calif., Oct. 13-17. The papers of most interest to *Power* readers are:

"Transmission at 220 kv., on Southern California Edison System," a composite paper by members of the Southern California Edison Co. (Sec. 1, "Description of System and Operating Experience," by H. Michener; Sec. 2, "Protective System," by E. R. Stauffacher; Sec. 3, "Economic Studies in Transmission-Line Design," by W. D. Shaw and C. B. Carlson; Sec. 4, "Vibration of Conductors and Overhead Ground Wires," by J. M. Gaylord; Sec. 5, "Location and Right of Way," by V. D. Elliott); "A High-Voltage Wattmeter," by P. C. Clark and C. E. Miller; "Power Measurements at High Voltages and Low Power Factors," by J. S. Carroll, T. F. Peterson and G. R. Stray; "Large Steam-Turbine Generators," by W. J. Foster, E. H. Freiburghouse and M. A. Savage; "Operating Features and Technical Problems Associated with Interconnected Systems," by W. E. Mitchell; "Electric Currents Due to Fields Alone," by S. S. MacKeown; "Electrical Application to Irrigation Pumping," by R. H. Cates; "Electricity in the Cement Industry," by Mr. Arnold; "Electric Power Application in Fir Mills," by J. L. Wright; "Electricity in Mines," by F. L. Stone; "Contribution of Electricity to the Steel Industry," by K. A. Pauly; "Electrical Equipment of Consolidated Mining and Smelting Company's Zinc Plant," by R. H. N. Lockyer; "Electrometallurgical Applications," by J. L. M. Yardley.

Society Affairs

The American Association of Engineers has re-established its Washington, D. C., office which was opened on July 15 at 712 Investment Bldg., 15th and K St. The office will be in charge of A. B. McDaniel.

The American Society of Civil Engineers on Aug. 15 took its second canvass of ballots for nominees for officials of the society. Robert Ridgway was chosen as president, receiving 3,188 out of the 4,330 votes cast.

The Milwaukee Section of the A.S.M.E. has announced the personnel of the local executive committee which will be in charge of all the arrangements and preparations for the A.S.M.E. spring meeting, which will be held in Milwaukee in 1925. The members are Fred H. Dorner, Robert Craemer, W. C. Lindemann, Arthur Simon, A. C. Flory, C. A. Cahill, John D. Maurer, Will J. Sando and E. F. Johns.

Personal Mention

W. H. Patchell, president of the Institution of Mechanical Engineers of England, is visiting in the United States.

Victor J. Azbe, consulting engineer, of St. Louis, has removed his office and laboratory to the Connor Bldg., 6625 Delmar Boulevard, St. Louis, Mo.

Fred R. Low, editor of *Power* and president of the A. S. M. E. returned home on Aug. 22, from Europe where he has been attending the World Power Conference and other meetings.

H. A. Woodworth, formerly with the Union Electric Light & Power Co., St. Louis, announces that he has severed his connection with that company and will open an office for consulting engineering in St. Louis.

A. N. Clark, formerly superintendent of power, Wyoming division of the Susquehanna Collieries, Wilkes-Barre, has recently become affiliated with the E. I. du Pont de Nemours Co., Wilmington, Del.

William Swan Elliot, of the Elliot Co., Pittsburgh, Pa., has recently received the Edward Longstreth Medal awarded by the Franklin Institute of Pennsylvania, for his invention and development of a method and apparatus for the deaëration of liquids.

Harry U. Wendell, for the last six years engineer of the New England Sanitarium, Melrose, Mass., has been appointed engineer of the Massachusetts State Sanitarium at Rutland, succeeding Walter C. Brown, who retired according to law on Aug. 1. James Mulvey has been appointed assistant engineer.

F. G. Switzer, recently promoted as professor of hydraulics, in the College of Engineering, Cornell University, has been granted a leave of absence in order to undertake work for the Alabama Power Co. in connection with its water power plants. He will be located in the Birmingham office.

Obituary

Sir George Bielby, F.R.S., chairman and director of a Fuel Research Board of Great Britain, died Aug. 1, at Hampstead, England. Although better known as a chemist, in his later years he gave much of his attention to fuel research and economy and was the instigator of the Fuel Research Station in East Greenwich, England, where he worked out a practical method of making coals from unsuitable seams serviceable for low-temperature carbonization by blending them in appropriate mixtures.

Business Notes

The Fuerst-Friedman Co., Cleveland, Ohio, dealers in power-plant equipment, announces that the firm is moving to new quarters at the corner of Hamilton and East 53rd St., Cleveland, Ohio.

The Gerard Electric Co., which lately moved from 69 Beach St. to 92 Pearl St., Boston, Mass., has been appointed service and parts agent for New England for the Kellogg Manufacturing Co., Rochester, N. Y., makers of air compressors.

The Sanford Riley Stoker Co., Worcester, Mass., has taken over the entire business of the United Machine & Manufacturing Co., of Canton, Ohio, and will handle this company's business in the name of the Sanford Riley Stoker Co., with head offices at Worcester, Mass., and plants at Worcester, Detroit, Mich., and Canton, Ohio. The Sanford company will now handle the Riley, Jones, Murphy and Harrington stokers which makes it possible for the company to sell stokers for any grade of fuel such as culm, lignite, anthracite screenings, coke breeze, refuse, etc. Mosher separators, heretofore made by the United Machine & Manufacturing Co., will be manufactured and sold by the A. W. Cash Co., Decatur, Ill., a subsidiary of the Sanford Riley Co., which manufactures boiler specialties, etc.

Trade Catalogs

Refractories — General Refractories Co., Philadelphia, Pa. This company has recently published a catalog covering the products manufactured by it. Photos of shapes and plants, tables of dimensions, temperatures, general information about firebricks, etc., are included.

Stokers—The American Engineering Co., Philadelphia, Pa. A catalog describing the new Taylor stoker has just been published and is ready for distribution to those requesting it. Photos of installations, explanatory drawings and photos add to the worth of this catalog.

Filters — Cochrane Corporation, 17th St. below Allegheny Ave., Philadelphia, Pa. Publication No. 1231 tells of the advantages of these filters for clarifying water for steam boilers, power plants, etc. Illustrations of installations and drawings of filters, as well as explanatory descriptions, make this catalog very comprehensive.

Steam Specialties — W. H. Nicholson & Co., 12 Oregon St., Wilkes-Barre, Pa. Catalog No. 24 describes the steam separators, traps and valves manufactured by this company. The Wyoming line will now be known as the Nicholson line. Bulletin No. 323 describes "Expansion Steam Traps," suitable for any pressure from 0 to 200 lb. Bulletin No. 824 covers the super-trap for super-pressure and super-heat in the super-power plant. The catalogs and bulletins are well illustrated and include tables of dimensions and price lists.

Coming Conventions

American Ceramic Society. Ross C. Purdy, Lord Hall, Ohio State University, Columbus Ohio. Convention at Los Angeles, Calif., Oct. 6-7.

American Chemical Society. Dr. Charles L. Parsons, 1709 G St., N. W., Washington, D. C. Sixty eighth meeting at Cornell University, Ithaca, N. Y. Sept. 8-13.

American Electric Railway Association. James W. Welsh, 8 West 40th St., New York City. Meeting at Atlantic City, Oct. 6-10.

American Electrochemical Society. Dr. Colvin G. Fink, Columbia University, New York City. General meeting at Detroit, Mich., Oct. 2-4.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Fall convention at Pasadena, Calif., Oct. 13-17.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Autumn meeting at Birmingham, Ala., Oct. 13-15.

American Society of Civil Engineers. 29 West 39th St., New York City. Fall meeting at Detroit, Oct. 23-25.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 1-4.

American Society of Refrigerating Engineers. W. H. Ross, 35 Warren St., New York City. Annual meeting at New York City, Dec. 1-3.

Association of Edison Illuminating Companies. P. S. Millar, 80th St. and East End Ave., New York City. Meeting at Griswold Hotel, New London, Conn., Sept. 8-12.

Association of Iron & Steel Electrical Engineers, John F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Annual meeting and exposition at Duquesne Garden, Pittsburgh, Pa., Sept. 15-20.

Eastern Ice Manufacturers Association. W. H. Ross, 35 Warren St., New York City. Eighteenth annual meeting at Hotel Chelsea, Atlantic City, N. J., Nov. 12-14.

Franklin Institute of Pennsylvania, Centenary Celebration at Philadelphia, Sept. 17-19.

Illuminating Engineering Society. Norman D. MacDonald, 29 West 39th St., New York City. Convention at Briarcliff Lodge, Briarcliff Manor, N. Y., Oct. 27-31.

International Union of Steam and Operating Engineers. Dave Evans, 6334 Yale Ave., Chicago, Ill. Biennial convention at Detroit, Mich., Sept. 8-13.

National Association of Practical Refrigerating Engineers. E. H. Fox, 5707 West Lake St., Chicago, Ill. Convention at New Orleans, La., Nov. 11-14. Exhibits at the Isaac Delgado High School.

National Association of Stationary Engineers. Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Hotel Pantlind, Grand Rapids, Mich., Sept. 8-13. Annual conventions and exhibitions of the state associations are scheduled as follows: **Michigan Association** at Grand Rapids, Sept. 8. Wm. H. Yeomans, 209 Plainfield Ave., Grand Rapids. **Pennsylvania State Association** at Grand Rapids, Mich., Sept. 8. J. N. Calvert, Union & Ridenour Ave., Crafton, Pittsburgh, Pa.

National Exposition of Power and Mechanical Engineering. C. F. Roth, Grand Central Palace, New York City. Annual exposition at New York City, Grand Central Palace, Dec. 1-6.

National Safety Council, W. H. Cameron, 168 N. Michigan Ave., Chicago, Ill. Thirteenth Annual Safety Congress at Louisville, Ky., Sept. 29 to Oct. 3.

New England Water-Works Association, Frank T. Gifford, 715 Tremont Temple, Boston, Mass. Annual convention at Powers Hotel, Buffalo, N. Y., Sept. 23-26.

Condensers — Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Circular No. 1662 is an attractively gotten up catalog describing with photos and performance charts, steam condensers of the surface, low level jet and barometric types; auxiliary equipment such as air-removal apparatus, pump drives, motors and control equipment.

Combustion Regulators — Garrick Engineering Co., 538 South Clark St., Chicago, Ill. Catalog No. 99 "The Automatic Control of Combustion," tells of the benefits to owners and operators of power plants, to be obtained through the reduced fuel costs and increased efficiency by the use of these mercury actuated controls. The catalog, a good presentation of the subject, is well illustrated with explanatory drawings and a list of automatic control systems is given on page 7. Bulletin M describes regulators for forced-draft stoker systems, natural-draft systems and powdered-coal systems, in all 33 systems.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Aug. 11, 1924	Aug. 18, 1924
Pool 1	New York	$2.35	$2.35
Smokeless	Columbus	2.25	2.15
Clearfield	Boston	2.35	2.35
Somerset	Boston	2.40	2.50
Kanawha	Columbus	1.55	1.55
Hocking	Columbus	1.65	1.65
Pittsburgh No. 8	Cleveland	1.90	1.90
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.50	2.50
West Ky.	Louisville	1.85	1.85
S. E. Ky.	Louisville	1.75	1.75
Big Seam	Birmingham	2.00	2.00

FUEL OIL

New York—Aug. 21, light oil, tank-car lots, 28@34 deg. Baumé, 4⅜c. per gal., 36@40 deg. 5¼c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Aug. 12, tank-car lots f.o.b. St. Louis; 24@26 deg., $1.50 per bbl.; 26@28 deg., $1.55 per bbl.; 28@30 deg.; $1.60 per bbl.; 30@32 deg., 4¼c. per gal.; 32@36 deg., gas oil, 5c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Aug. 13, f.o.b. local refinery, 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 5½c. per gal.; 34 deg., neutral, 8½c. per gal.

Dallas—Aug. 15, f.o.b local refinery, 26@30 deg., $1.25 per bbl.

Philadelphia — Aug. 8, 28@30 deg., $2.05@$2.113 per bbl.; 18@22 deg., $2.075@$2.139; 13@16 deg., $1.78½@$1.848 per bbl.

Boston—Aug. 4, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4⅞c. per gal., light oil, 28@32 deg. Baumé, 6⅞c. per gal.

Cincinnati — Aug. 19, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 4⅜c. per gal.; 26@30 deg., 4½c. per gal.; 30@32 deg., 5c. per gal.

Chicago—Aug.18, 20@22 deg., 5½c. per gal.; 24@26 deg., 6c. per gal.; 28@30 deg., 6c. per gal.

New Plant Construction

Calif., Hanford—Lucerne Irrigation District plans irrigation works for approximately 35,000 acres, water to be stored in reservoirs, several pumping plants to be installed. M. Enderlein, Brix Bldg., Fresno, is engineer.

Idaho, Boise — Bureau of Reclamation, Denver, Colorado will receive bids until September 29th, for furnishing two 6,000 hp. hydraulic turbines, two 5,000 kva. generators, transformers and switching apparatus for the Black Canyon power house.

Ill., Centralia—Pearse, Greeley & Hanson, Engrs., 6 North Michigan Ave., Chicago, will receive bids until September 4th, for filtered water reservoir, head house, etc., including two 3,000,000 gal. steam turbines, and one 5,000,000 gal. steam turbine, low lifts, estimated to cost, $125,000.

Ill., Harvey—The Whiting Corporation, 155th St., has awarded the contract for a boiler house and machinery factory to T. D. Hobson, estimated cost, $40,000. Chatten & Hammond, 160 No. LaSalle St., Chicago, are architects.

Ind., Anderson—Hughes Curry Packing Co., c/o C. E. Hughes, 1800 West 8th St., will receive bids until Sept. 1st, for factory and office building. Refrigerating and packing machinery will be required.

Ind., Julietta — The Board of County Commissioners of Marion County, at Indianapolis, is receiving bids for the installation of a 50 kw. engine and generator, together with necessary equipment, for the power plant at the asylum for insane here.

Ia., Hawarden—The City, F. A. Gefke, Clk., will receive bids until Aug. 29th for the construction of an electric light and power plant, including equipment, $50,000 bonds voted recently for project. K. C. Gaynor, Trimble Bldg., Sioux City is engineer.

Kan., Reserve — The City Council will soon take bids for waterworks and distribution system, including two pumps, etc., estimated to cost $16,000. Shockley Eng. Co., 800 Graphic Arts Bldg., Kansas City, are engineers.

Ky., Louisville—The United States Engineer's Office, Louisville, is in the market for two steam pile hammers, about 6,500 lb. each, estimated cost $1,750 each; one 15 kw. 110 volt, direct connected reciprocating steam driven electric generating set with switchboard, $2,000; hoisting engine, 12 x 16 in. cylinders with three drums, 20-in. diameter for use at Dam No. 41, Ohio River, $6,000; four 3 drum 10 x 12 in. hoisting engines with boilers, four 1 drum 8¼ x 10 in. hoisting engines, four 1 drum 4 x 5 in. swinging engines and four lever stands for maneuver boats.

Minn., Faribault — City c/o S. M. Andrews, City Clk., plans municipal electric light and power plant, also garbage disposal plant. Engineers are invited to submit plans, ideas and cost estimate.

Mo., Doniphan—Doniphan Light & Ice Co. plans to purchase two oil engines 60 or 70 hp. direct connected to generators of 50 or 55 kw. each.

Nev., Fallon—The City Council rejected bids received July 30 for furnishing 1 or 2 Diesel or Semi-Diesel type engines. Fairbanks-Morse Co., San Francisco, submitted only bid at $56,528.

N. J., Asyla — Board of Freeholders, Court House, Camden, has awarded a contract for the construction of a boiler house to L. Hurley, 515 Lawrence St., Camden, $17,250.

Ohio, Ashtabula—The City has awarded the contract for an addition to its power plant to Alexander Bros., Williamson Bldg., Cleveland. Estimated cost $60,000.

Okla., Newkirk—City plans election Aug. 26, to vote $115,000 bonds for new water supply including pumping equipment. T. B. King, Grain Exchange Bldg., Oklahoma City, is engineer.

Okla., Oklahoma City—The Huckins Hotel Co. is having plans prepared for a new laundry building to include an individual power plant. Boilers, generators and lighting equipment will be installed. Address Mr. Bevens.

Every one of these items is reported by our authorized correspondents who are instructed to verify every item sent in. This free weekly service is published in the interests of the buyer and the seller, to bring them together and get machinery moving.

Everything possible is done to insure authenticity and timeliness.

Your co-operation is invited in helping us maintain this service at the highest efficiency.

BUSINESS NEWS DEPARTMENT
Tenth Ave. at 36th St., New York

Pa., Latrobe—Vanadium Alloys Steel Co. has awarded the contract for the construction of a 70 x 260-ft. boiler house and hammer shop, to J. F. Haldeman, 627 Gettysburg St., Pittsburgh. Hunting Davis Co., Century Bldg., Pittsburgh, are architects.

Pa., North Side (Pittsburgh P. O.)—D. L. Clark Co. will build power house on Martindale St., estimated to cost $45,000. P. Dietz, Lyceum Bldg., Pittsburgh, is engineer.

Pa., Philadelphia—Children's Home Hospital, Franklin & Thompson Sts., will soon award contract for a group of buildings including power house and laundry. A. W. Barnes, Perry Building is architect.

Pa., Philadelphia—Department of Public Works, Bureau of Surveys, City Hall, will receive bids until August 27th, for transformer building and equipment for Northeast Sewage Treatment Works, Wheatsheaf Lane and Richmond Street.

R. I., Providence—Narragansett Electric Light Co. are having plans prepared for a turbine building, estimated to cost $50,000. Jeulss & Ballou, 10 Weybossett St., are engineers.

Tex., Waco—Board of Commissioners and T. P. Stone, Mayor, will receive bids until September 15, at the office of G. D. Field, City Secretary, for sewage treatment plant, including furnishing and installing pumps, motors and control apparatus for two pumping stations and pumps, internal and combustion engines for emergency drainage pumping station; main pumping station; 4 pumps, total capacity, 13¾, M.G.D., emergency pumping station, pumps total capacity, 12 to 23 M.G.D. and East Waco pumping station, 2 pumps, one 300,000, one 600,000 G.P.D. Terrell Bartlett Engineers, Inc., 610-614 Calcasieu Building, San Antonio, Texas, are engineers.

Alta., Calgary — Calgary Water Power Co. plans to purchase a large generator and other machinery for new plant at Bow River for the Eau Claire Power Co.

N. S., Windsor—Town has adopted a by law for $5,000 to purchase waterworks equipment.

Ontario — The Backus Brooks Lumber Co., E. W. Backus, Pres., 1100 Builder's Exchange, Minneapolis, Minn. plans to expend several million dollars on rebuilding of the Norman dam on the Lake of the Woods, to provide sufficient power for the new paper plant at Kenora.

Ontario — Councils of King and West Gwillimbury Townships, F. Ritchie, Bradford, Clerk, are having plans prepared for drainage of 7,500 acres swamp lands. Work will include pump house with pumps, boiler, engine and other equipment. Owners are interested in prices on all equipment. A. Bairu, Sarnia, is engineer.

Ont., Forest—The City Council is interested in prices on pumps and other equipment for waterwork system, estimated to cost $50,000. J. Bell, Court House, St. Thomas, is engineer.

Ont., Fort Erie—The Town has passed a by law for $20,000 to purchase equipment for sewerage pumping station.

Ont., London—A. Buchanan, Genl. Mgr. of Public Utilities is interested in prices on Diesel engine and electrical pumping equipment for waterworks, estimated to cost $80,000.

Que., St. Joseph D'Alma—Price Bros. Co. Ltd., Quebec, plans the construction of a power plant in connection with their proposed new paper mill.

Argentine, Mendoza—The Argentine National Sanitation Works Dept. are calling for tenders, to be received until October 6th, for the supply and delivery of machinery for a hydro-electric station to be installed here. The plant required includes horizontal turbines, 3-phase generators, switchboard, etc.